AMERICAN MACHINIST

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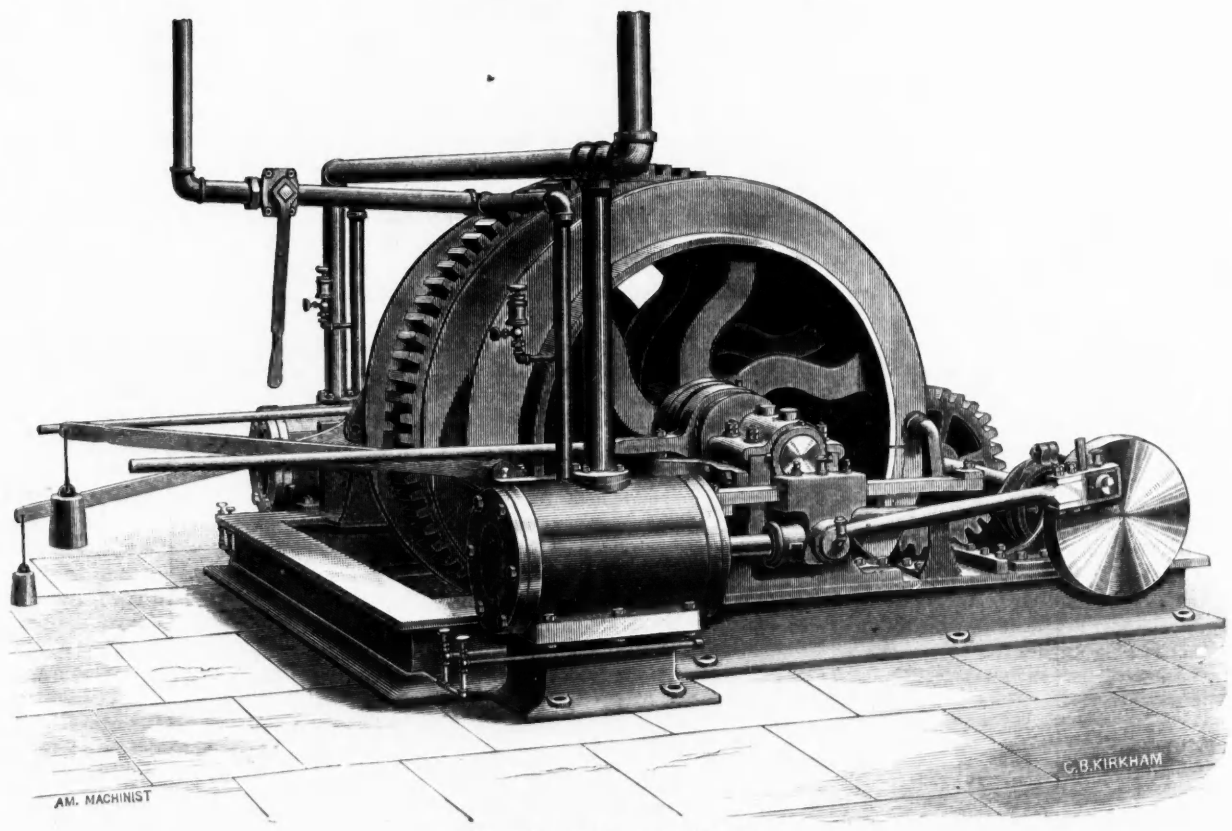
Wire Rope Haulage Engine.

With this we present an engraving of a geared mine haulage engine, built by J. & J. B. Milholland, Pittsburgh, Pa. Various styles of these engines are made by the builders, the one illustrated being 40 horse-power, and having drums of sufficient capacity to hold one and a half miles of ⅝″ steel wire rope. On ordinary grades, forty mine wagons, each containing two and a half tons of coal, have been hauled from mines with it.

The cylinders are 12″ diameter and 16″ stroke, and are secured to a heavy and substantial frame by bolts, which are driven to their places in reamed holes. The proportion of the gearing is four to one, the gears employed being sufficiently heavy and of sufficient diameter to make them capable of standing any strain to which they can be subjected. The drums are 4 feet diameter and 8″ wide on the face; they are loose on the drum shaft, are bushed with brass, and can be connected or disconnected at will by the engineer. This style of haulage is considered especially advantageous where it is found necessary to place it in the mine, as its construction makes it easy to get it down into the shaft.



WIRE ROPE HAULAGE ENGINE.

There are a good many readers of the AMERICAN MACHINIST who will visit the Paris Exposition this summer and fall, and not all of them will be able to secure passage on one of the two or three boats famous for breaking the record. Those that are disappointed in this can console themselves with the thought that, in the opinion of some who have tried both, the boats that require a day or two more time in which to make the passage are the more comfortable ones upon which to travel.

The Modern Steam Plant and its Management.

BY PETER H. BULLOCK.

CLEANING FIRES.

A few more suggestions about the fire-room. To properly clean a heavy, hard coal fire is an operation that will severely tax the strength, skill and endurance of a fireman. This statement may seem strange to those who are used to a small furnace, and who clean (?) their fires by running their pokers in on the grate, breaking it up through the coal, and then raking the larger clinkers off from the surface. But this is not properly cleaning a hard coal fire—it simply removes the large clinkers, and mixes the small ones and the good coal all up together in an excellent shape and condition to quickly raise another crop of large clinkers. To clean a heavy and dirty fire, that is, perhaps, a foot thick, requires judgment in nursing it into condition, as well as skill to perform the operation. If it is attempted when not in condition, the chances are pretty strong that the fire will be lost. There must be a surface of coal that is not too much burned out, and at the same time not too fresh, but thoroughly ignited in order that it may retain sufficient heat to quickly start the fresh coal into combustion.

When but one boiler is being run, and in order to prevent the steam from getting too low, one side of a fire can be cleaned at a time; but, if possible, it is best to do the whole furnace at once. In getting ready to clean, there are other things to look after besides the conditions of the fire itself. The water should be got up to the highest point allowable, and then, after waiting a few minutes for the whole body of it to get up to the steam-making temperature, operations may begin.

I will now describe the act, just as I saw it done in a well-regulated fire-room, some few months since. There were four sixty-inch boilers, with furnaces 56 inches wide and 6 feet long. The fuel was Lehigh coal, furnace size, and good in quality. One fireman and one laborer did the work in the fire-room, and in a most satisfactory manner. The fire to be cleaned looked clean and bright over its whole surface, and there was no visible indication of the large amount of dirt that was under that glowing crust of coal. When ready, he took a "lazy bar" shown in Fig. 8, page 2—(this is simply a piece of ¾ round iron bent as shown, to hook over the knob of the door that is closed, and over the hinge of the one that is open; and, of course, will go just the same when the other side is being cleaned; it is simple to make, and makes it possible to use a heavy hoe with accuracy and ease)—and with a heavy hoe he shoved the crust of good coal back to the bridge wall, leaving fully two-thirds of the length of the furnace on that side with nothing but a bed of dirt and clinkers covering the grate. The helper then brought the edge of the iron wheelbarrow under the furnace door, and all the exposed dirt was quickly pulled into it. When the same operation was done to the other side, the clean coal that had been shoved back, together with that which had not been moved, was then pulled forward and left in an oval heap, the back edge of the good coal being just forward of the remaining dirt in the back end of the furnace.

The next operation, pulling the dirt and clinkers over the good coal without mixing them up, is one that requires judgment and skill, but it is done daily by hundreds of good firemen, and in a way that deserves praise from all who appreciate good firing. After this dirt was deftly pulled over the coal, and into the waiting wheelbarrow, the incandescent mass of clean fuel was then gently pushed back so as to cover the whole grate, and fresh coal lightly spread over the whole surface of it. The draft was then partially thrown on, and in five minutes after there was a sheet of blue and white flame over the entire furnace, which then contained a clean fire, not over five inches thick, in place of a mass twelve inches thick less than twenty minutes before. The actual time occupied in cleaning was about thirteen minutes, and the steam on the whole battery had not fallen more than four or five pounds. No water was pumped into this boiler until the fire was burning sufficiently strong to maintain its part in steam-making.

In cleaning a soft coal fire the same methods are advisable, but it is not necessary to use so much caution in getting the fire into condition, for soft coal will kindle under far less favorable circumstances than will hard coal; but in either case it will not do to fire heavily onto the thin layer of coal, for there is danger of smothering it out, or of there not being heat enough in it to ignite a large mass heaped upon it.

The best *idea* I ever saw for cleaning a fire was where the back end of the grate was made to dump, and the operation was as follows: The good coal was drawn forward off from the dumping section, which was then dropped and replaced, the clear coal pushed back onto that section, and the dirt from the front part pulled out the door, the same as in cleaning a fire in the regular way. The good coal was then spread and covered as usual, but there were practical difficulties in dumping and replacing so large a section of grate that was not fully overcome, and, like some other good ideas, it never came much into use.

You may have noticed that I spoke of the "whole body of water getting to the steam-making temperature," and before anybody gets onto my neck and begins to read the table of pressures and temperatures to me, I want to explain that I have no doubt about the correctness of those tables, but that conditions may exist in boilers where these laws do not assert themselves very rapidly. Take, for instance, a boiler with any given pressure—say 80 lbs.—and stop using steam from it; you may pump it nearly full without materially lowering the pressure, but that the water is not at a corresponding temperature can be proved by using some steam, when you will find that the pressure will quickly drop to the point where the water will begin to give off steam, and if the amount of water that has been put in is large in quantity and low in temperature, the pressure may go to a point that will surprise you. It is far easier and quicker to stop a boiler from making steam than it is to get the necessary conditions into operation for generating it. A boiler, with a good fire under it, and the usual amount of water inside, can be very quickly stopped from making steam by heavily covering the fire, closing the drafts and pumping in a large amount of water; for the heat of the fire will be absorbed by the fresh coal, and the temperature of the water inside is quickly lowered by the colder water that mingles with it. It will, however, require some time to get the boiler to making steam again, for the coal must be got well to burning, and the whole body of water got to the proper temperature, be-

fore you will get steam at the pressure desired.

In the other direction there are also conditions under which a boiler will absorb heat in excess of what the pressure may show. I am fully aware of the fact that I am stating what perhaps cannot be exactly proved, but a fact, nevertheless, that has been noticed by others beside myself. It will frequently occur in a boiler that has been standing for a long time, with a large body of water inside, and a dull fire under it, and is probably caused by a lack of circulation. It has come under my observation that where these conditions exist, a boiler will part with more heat-steam for the first few minutes after the throttle is opened, than could by any possible means be generated by the dull fire during so short a time, and that the pressure will often hold its own, or even slightly increase for a short time after beginning to draw steam from the boiler.

In all firebrick furnaces there is a constant tendency to accumulate clinkers on the sides and bridge wall. Sometimes this can be partially prevented by using air-slacked lime mixed with soft coal, along the sides where the clinkers are, or a few shovelsful of oyster shells in the same place if hard coal is used. When they have once got burned on, it is not best to try and break them off with the slice bar, as that is apt to loosen the walls, but wait till the furnace is cool, and then chip and split them off with a pointed chisel.

MOVING SAFETY VALVE WEIGHTS.

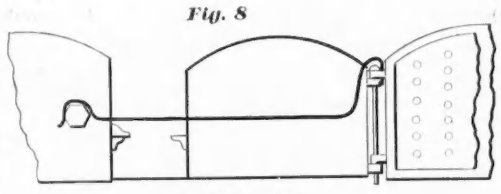
It is a good plan to run a cord or chain from the safety valve lever over pulleys and down in front of the boilers, so as to be able to reach them at any time. If it becomes necessary to move the weight, the valve lever should be grasped by one hand and held down hard, while the other hand is left free to move the weight. This may seem a simple matter to write about, but send the average man onto the top of a boiler to move the weight, and the result is usually a series of puffs and blowings that are entirely unnecessary.

One of the most aggravating and uncalled-for accidents that ever happened to a plant the writer had charge of, occurred some years ago, and was caused by an assistant attempting to move a weight by rapping it along the lever with a hammer. The cast-iron lug broke off, the weight carromed on his foot, the lever, rapidly moving in the opposite direction, stripped the clothes from the upper part of his body, and the escaping steam, with an initial pressure of 90 lbs., and the area of a 5" valve striking him in the rear, blew him clear off from the top of the boiler, and dropped him, with a large amount of other debris, in a passageway at the rear of the boilers. Four boilers were running at the time, and nothing could be done until they were entirely emptied of steam. The actual cost of repairs was simply the putting of a wrought-iron lug into the weight; but six hundred men were idle for two hours, and the writer always feels chagrined at any delay that may arise from a fault in his department.

Nothing will quicker gain the confidence of employes than always having the power ready to start promptly on time, and to run regularly during working hours. Stationary engineers should feel the same pride in avoiding delays that the locomotive engineer feels in always being able to get his train in without assistance. The success of many engineers is largely due to their happy faculty of always being able to see their way out of all little difficulties that may arise; of never getting stuck; of being ready with some expedient to keep things running till full and regular repairs can be made. Skill and experience are prime qualifications for an engineer, but he that is also fertile in expedients has the inside track for success. The man that frequently stops during working hours to tighten up some bolt, or adjust some spring, thus keeping perhaps hundreds of hands idle, is one that either does not carefully look over every part of his engine before starting, or he is one that is barren of expedients.

Not long since I entered the engine-room of a man that always "gets there," and saw a strip of board screwed to the floor, with one end reaching under the valve motion, and attached with a piece of belt lacing to a part of it that had to be pulled back at each stroke of the valve gear, the spring that usually did this being broken. Just then the proprietor came in and asked what the board was doing there, and when Jim showed him the broken spring, he at once asked, "How long did you have to shut down?" "Not at all," said Jim. "I got the fireman to pull on the rod till I rigged up the board; but I am going to put in a new spring this noon." The satisfied look on the face of the proprietor seemed to me to portend a steady job for Jim. If he had come in and found everything shut down while a new spring was being put in place, I doubt if he would have felt like complimenting Jim, as he afterwards did when referring to the matter.

Fig. 8



LAZY BAR

Of course things will sometimes happen that will make running impossible until full repairs are made, but it is also true that very frequently valuable time is taken for small repairs that might be saved if a little ingenuity was shown in devising ways and means of getting over difficulties that arise. A good many years ago, when a workman in a country jobbing shop, a man brought in a broken steam chest cover, and the job was given to me to make a new one, and eight new stud bolts. As I knew this came from a saw-mill where work was driving, I supposed they would be in a rush for it; but the owner said not to put any overtime or extras onto it, for he was in no great "fret" about it. On further inquiry I found that an oak plank was acting as a cover *pro tem.*, and that it was securely held in place by logging chains and wedges; and, furthermore, that they were only idle an hour when the cover gave way. *Somebody* around that mill was rich in expedients, and all, from the proprietor to the log rollers, were enriched by his faculty of seeing how to do things.

In the management of a large steam plant there are always opportunities arising for the exercise of these faculties, and also for utilizing and elaborating the suggestions of others. My own experience has taught me to respect the ideas of others, and while I do not advertise for advice, nor act on all I get, still I freely acknowledge receiving many valuable hints and suggestions from very humble sources. A suggestion made by a log driver on a Canadian stream, regarding the handling and transportation of a boiler, was once adopted by the writer, and it was far better than the way I had proposed to do the work; yet this man had never before seen a steam boiler, nor did he know the first principles of mechanics, but he was schooled in the movement of heavy masses, and, best of all—he had good "horse sense."

The variable exhaust damper which we have noticed in our issue of September 15, 1888, has been very favorably received on many roads. Mr. H. A. Luttgens, of Paterson, N. J., its inventor, continues to receive flattering reports, each showing that, with the adoption of the damper, an economy in fuel is obtained. In regard to the adoption of the damper, Mr. Luttgens says: "I find that smaller companies will appreciate the merits of an improvement sooner than the larger companies, and are often quite enthusiastic about its performances, all the officers of the company becoming interested in the result. With large companies the multiplicity of cares placed upon the superintendents of motive power often prevents, to a certain degree, the attention to particulars and smaller matters."

Experiments made with hard and soft coal burning engines seem to indicate a saving of fuel ranging from 13 to 15 per cent.

A Simple View of the Theoretical Efficiency of Vapor Engines.

BY PROF. JAMES E. DENTON.

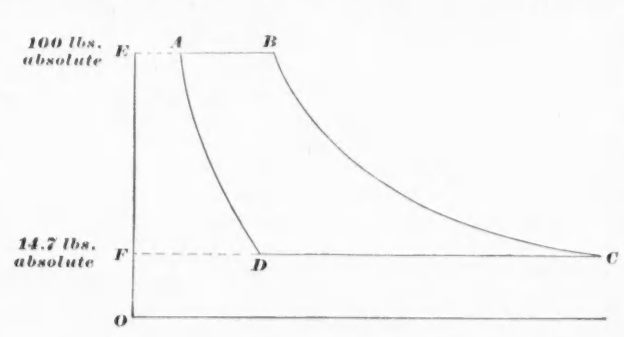
In reference to the discussion of Prof. Wood's paper on "Vapor Engines" at the Erie Meeting of the American Society of Mechanical Engineers, I have prepared the following condensed statement of the possible economy of engines using various substances as a heat medium.

The computation of the table is to be credited to Prof. D. S. Jacobus, of Hoboken.*

It applies to engines whose indicator cards would be like the accompanying figure, *E A* representing clearance volume, the compression line *D A* being arranged to compress to boiler pressure before the valve opens for admission, and the terminal pressure being that of the atmosphere, with the point of release assumed at exactly the end of the stroke.

Under these conditions, the influence of clearance on economy is entirely eliminated, and if the efficiency be computed without regard to cylinder condensation, we shall obtain the maximum economy that can be expected to be realized between the pressures chosen, and yet we shall have introduced no condition inconsistent with the use† of a vapor in a modern high-pressure engine. Column 7 of the table expresses the fraction of the heat in the vapor (when it enters the working cylinder) which is realized as work, or which is represented by the indicated horse-power computed from the diagram *A B C D A*. It will be seen that these fractions are practically the same for all the vapors. Leaving the air out of consideration for the present, let us consider the reason for this absence of difference of economy of the vapors, notwithstanding that there is so much difference in their boiling points, latent heat, etc.

Thus, steam boils at 212°, ammonia at minus 27°. Steam requires about twice the heat for the generation of a pound of its vapor than does ammonia. Again, ether, which boils at 95°, requires but 0.55 as much heat to change the temperature of its liquid one degree, as does liquid water, and but about one-fifth as much heat to generate a pound of its vapor. Evidently there must be some very general neutralizing element underlying the effect of such widely differing properties upon the efficiency of a vapor, when used as a medium for the transformation of heat into work in an engine, and my object is to suggest a view of the subject which will bring this element into prominence.



The useful effect or "efficiency of fluid" given in column 6 is simply the quotient of the mean effective pressure of the diagram *A B C D A*, divided by the heat possessed by as much vapor as will fill the volume *A B*, or the displacement of the engine piston up to the point of cut-off.

Now, the expansion line *B C*, and the compression line *D A*, differ so little for all these vapors, that the mean effective pressure differs no more than is due, say to the variation of expansion lines in indicator cards of various steam engines, from the Mariotte law of expansion or compression.

For practical purposes, therefore, the mean effective pressure, or the numerator of the efficiency value is the same for all the vapors for equal ratios of expansion. But the heat which must be expended is far less in the cases of some of the vapors than in the case of steam for equal *weights* of substance, such heat being given in column 5 of the table.

If, for example, the space or piston displacement *A B*, when filled with ether vapor at 100 pounds pressure, contained as much *weight* of ether as it would of steam, then the efficiency of ether would be represented by a fraction whose numerator would be the same as that for steam, but whose denominator would be less in the proportion of 195 to 1,002. In other words, the ether would be about five times as economical as steam. But the weight of a cubic foot of ether is nearly as much greater than steam as is 1,002 greater than 195. That is, to fill the volume *A B* with vapor of ether would take about as many times more pounds of ether as the heat to vaporize the latter is less than the heat to vaporize water.

Hence, to obtain a *given horse-power* from an engine, both the numerator and denominator of the efficiency value are practically equal for steam and ether, and the same principle is the cause of the close identity of the values in column 7 for other vapors, and extends also to air.‡

As a general principle, therefore, we may say that substances more volatile than water, in the sense of requiring less heat for the vaporization of a given weight—produce vapors so much more dense than steam, that, to produce *equal horse-powers* in a given engine, as much greater weight must be used of a vapor as is roughly represented by the ratio of the heat of its vaporization to that of steam; whereby the economy, neglecting differences of cylinder condensation, is practically the same for all common volatile substances as for steam. Experiments with naphtha and ammonia indicate that there may be less cylinder condensation with ammonia and naphtha than with steam—when the former are used so that they expand from a highly *superheated* condition, and the latter is used without superheating, so that a loss of upwards of 33 per cent. of the theoretical consumption of steam takes place through cylinder condensation. Line three of the table applies to the case of ammonia used as a superheated gas, distilled from an aqua ammonia solution. A practical application of ammonia for motive power purposes is being carried out on this principle. The use of ammonia in its saturated condition is, of course, impossible if it is to be condensed, and its waste thereby prevented. No means of condensing it at *minus* 27° Fahr. exists. It was proposed to use ammonia in such a cycle, however, some years since in the Gamgee or zero motor, which offered to boil the ammonia by the natural heat of the sea-water, and expand it to —27°, and return it to the boiler by some means never clearly defined, and yet unknown.

Experiment also has shown, in a satisfactory manner, that the rate of conduction of heat from the furnace to the liquid in the boiler is greater per square foot of heating surface per hour in the case of highly volatile substances, such as ammonia, naphtha and bisulphide of carbon than for steam. This fact makes it possible to produce a

* "Efficiency of Vapor Engines," STEVENS INDICATOR, Oct., 1888.

† The latest applications of bisulphide of carbon, ammonia, etc., as a motive fluid do not afford a back pressure practically less than the atmosphere, notwithstanding a condenser is used. For this reason, Prof. Jacobus confines his calculations to the diagram which exhausts against a pressure equal to that of the atmosphere.

‡ The air cycle covered by the table is what is known as Joules' Engine. See Art. 276, Rankine's Steam Engine. The air taken from the atmosphere is compressed along *D A* to 465° Fahr. and 100 pounds pressure. It is then passed through the furnace, and heated at constant pressure to 607° Fahr., the volume thereby becoming increased by the amount *A B*. Expansion then occurs along *B C*, whereby the temperature falls to 160°, and at this temperature the air is exhausted to the atmosphere.

given horse-power with less boiler capacity or heating surface than with steam; but it should be noted that the total heat expended per hour, or the economy, is not affected by this circumstance. The first cost of boiler plant will be less, but the heat which must be supplied to the vapor per horse-power will be practically the same as for steam, as per columns 6 and 7 of the table. Should steam be superheated, so that cylinder condensation may be eliminated, its economy will exceed that of any of the substances in the table, except air.

The difficulties of preventing superheaters for steam from deteriorating, has thus far so offset the extra economy known to result from their use, that no general use of superheated steam is now being attempted. The high temperatures involved in the use of air engines (which are known to actually realize most of the high economy promised by theory) has proved an insurmountable obstruction to their competition with steam. The use of volatile vapors, as substitutes for steam, involves objections quite as serious as these. To maintain a back pressure equal to that of the atmosphere requires an amount of water about equal to half that which affords 27 inches vacuum, with steam.

Theoretical Economy of Various Vapors Used as Heat Mediums in a Given Engine at Fixed Cut-off, the Expansion being Sufficient to Cause a Fall of Pressure from 100 to 14.7 lbs. per square inch. Mean Back Pressure, 14.7 lbs.

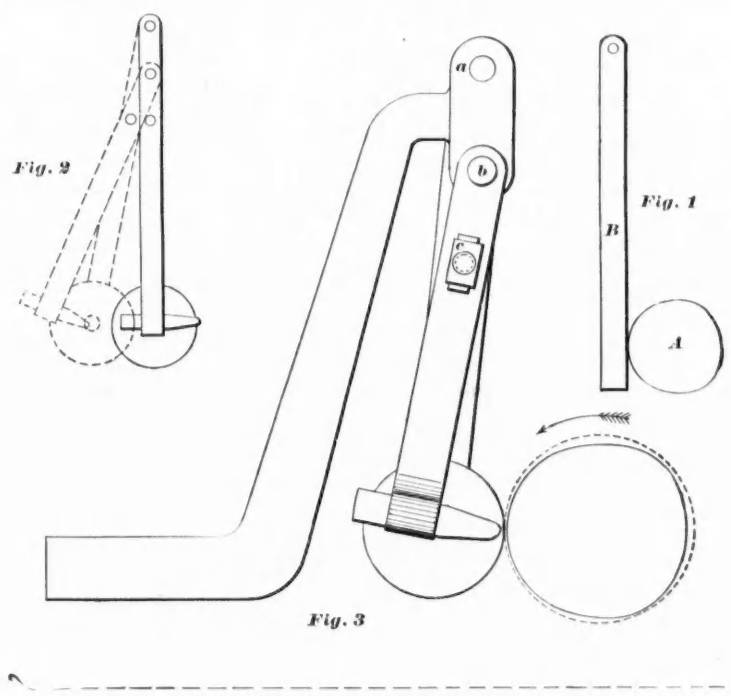
Substance used as a Heat Medium.	Specific Heat in Liquid Condition.	Temperatures in Degrees Fahrenheit at pressures per sq. inch of		British Thermal Units necessary to be expended in order to generate 1 pound of vapor from "temp. of feed" equal to that given in column 4.	Efficiency or Fraction of Heat Expended utilize 8,000 heat units per pound of coal. Cylinder condensation neglected—in pounds.	Coal per hour per indicated horse-power, assuming the boiler to generate 1 pound of vapor from "temp. of feed" equal to that given in column 4.	Probable coal per H. P. including allowance of ⅛d for cylinder condensation for saturated vapors and zero for superheated vapors—in lbs.
		100 lbs.	14.7 lbs.				
1	2	3	4	5	6	7	8
Steam	1.00	338	212	1002	0.14	2.3	3.1
Ammonia, saturated	0.99	56	—27	632	0.15	2.15	2.88
" superheated	0.99	282	8	940	0.13	2.48	2.46
Ether	0.55	215	95	195	0.15	2.15	2.88
Carbon Bisulphide	0.24	248	115	163	0.17	1.99	2.68
Air—worked as in Joule's Engine. See Rankine's "Steam Engine," p. 373.	0.24	607	70	160	0.46	0.70	0.70

There are more miles of railroad in the Australian colonies, in proportion to population, than in any other country in the world, except the United States.

The Improved Chalk Accelerator.

BY FRANK RICHARDS.

There seems to be always something unsatisfactory about chalk. Whatever you do with it you feel as if you could do it better by some other means. And so you can, every time. It is always more or less a temporizer and a makeshift. The young machinist early makes its acquaintance, and its influence may become a demoralizing one. When he comes to center or chuck work in the lathe, the full dominion of chalk may be said to be established upon him. How many generations of machinists—and, by the way, what is a shop generation? how many years is the average shop life? who knows?—how many generations of machinists have been revolving their work in the lathe, and chalking and averaging the high places, and getting scoldings innumerable because the low spots would not turn out? Does it not seem strange that, in all these years, chalk has held its baneful sway, and been continually grumbled at, that no one has ever fixed it so that it will touch and show the low spots instead of the high ones? Of course it could be done by a very simple mechanical device, but I suppose no one has happened to think of it. The necessity of it is one of those things of which we continually have illustration—that are too familiar to be thought of. They are too much below us, and too near to us to be visible, like the little dog that the fat man is looking for in the familiar picture.



IMPROVED CHALK ACCELERATOR.

The improved chalk accelerator is intended to remove the opportunity for remarks such as the above. I give it a kind of a patent office title, for nothing is ever new, but is only an improvement on what has gone before. I can scarcely believe this to be the one exception, and, if so, it will not remain so long. He invents best who invents last; so that he who comes first has but a slim chance. It seems scarcely fair, though, that the one who picks the ripened fruit should have the credit of raising the entire crop.

For a piece that is perfectly round, and that we wish to bring true at a single point, the method of touching the high point with chalk is right enough. So with a shaft, or any cylindrical piece, both ends may be made true in the same way, and then the whole piece will be true. But shafts, when round, are often crooked, rough forgings or castings are generally not round, and in all these, when revolving, the low spot that we want most of all to know about is always the inaccessible spot to the stationary piece of chalk.

Suppose *A*, Fig. 1, to be a circular piece revolving untruly, and that we wish to make concentric with the lathe, or, having a depression at some point, we wish to center the piece, so that this point will be as high or as distant from the center as a point on the opposite side of it, so that we can get from the piece a perfect circle as large as possible, or, as we say, so that it will turn up as large as it will clean. From a point above and in front of it we suspend a lever *B*, free to swing in and out, and held up to contact with the revolving piece by a weight, spring, or other suitable device. If this lever carried a piece of chalk in contact with the work to be trued up, the chalk would mark all around it, and that would do us no good. But, letting this lever retain its function of feeler, or follower, moving in and out in contact with the irregular or eccentric surface of the revolving piece, what we want is another lever carrying a piece of chalk, and swinging at the same time and in the same direction as the follower, but with a greater angle of movement. Then the excess of this movement would occur at one or both ends of the path traveled by the end of the lever, and the chalk being attached to it, the chalk could then be so adjusted as to touch the low spot of the work, which low spot would be one extremity of the line of movement. So then the name chalk accelerator, that I adopt for the apparatus, carries the whole principle of it. Many mechanical devices can be thought of to accomplish this accelerated movement, and I suggest only one, or rather two, of many that have occurred to me.

Both levers might have their fulcrum at the same point, and the upper part of the first lever, or feeder, might consist of a toothed quadrant working into the smaller pinion of a double or compound pinion above it. Then a larger pinion could engage with a quadrant of smaller radius than the first, forming the upper part of the chalk-carrying lever, and by this arrangement it is evident that the chalk lever would move faster and farther than the feeler.

But what I consider a simpler and better arrangement, we have in Fig. 3. Here we have the first lever suspended at *a* as before. It is placed upon the further side of the suspending bracket, and at the lower end of the lever, and upon the inner side of it is placed a roller, turning freely upon a fixed stud. This roller will enable the lever to follow the contour of the work more easily. The roller would also go to the bottom of any re-entrant depressions, if not too acute. The roller being placed upon the side of its lever nearest to the chalk, the roller and the chalk move close to each other, and the chalk marks the work very near the spot touched by the roller. The chalk lever is suspended at a point *b*, some distance below the fulcrum of the first lever, and it is moved by a fixed pin in the first lever, which passes into a hole in the sliding block *c*. It is evident that, by this arrangement, the chalk lever must always move farther than the first lever. If the first lever be swung back, as shown by the dotted lines, Fig. 2, the chalk lever is swung still further back.

Crayon chalk may be used, and for holding it the lower end of the lever may be split, and may have sufficient spring in itself to hold the chalk securely, or any suitable clamping device may be employed. The chalk will never require to be accurately adjusted, as the point of contact with the work may always be corrected by moving the whole apparatus in or out. The suspending bracket may be made with a base that can be placed upon a block laid across the lathe, or it may be made as in Fig. 3, with a shank to fasten in the tool post. It will be seen that the apparatus goes by contraries—to make the chalk travel further forward, draw the apparatus back; to withdraw the chalk, advance the whole thing. So, in beginning to use it at any time, the levers can be held back by hand, and the standard placed too near the work for the chalk to touch it; then, letting the levers swing freely, the roller touching the revolving work, the chalk will not, at first, mark anything, but can be made to touch as desired, by gradually drawing the standard backward. A spring, not shown, will be required to push the levers forward. The tension of spring required will depend somewhat upon the speed with which the work revolves, and, what is most satisfactory, can be best determined by experience.

Marine Boiler Incrustation.

In a paper on "The Formation of Marine Boiler Incrustations," read at the Institution of Naval Architects, by Professor Vivian B. Lewes, F. C. S., it was stated that analyses of specimens of deposits from boilers where sea water was used gave in all cases two distinct layers—(1) a hard crystalline deposit on the sides of the tubes, consisting of nearly pure calcium sulphate in the form of "anhydrite"; (2) a softer portion resembling alabaster in the interior consisting of calcium sulphate, with about 6 per cent. of magnesic hydrate. The presence of magnesic hydrate in boiler deposits is supposed to be due to the mutual decomposition of water and magnesic chloride; later experiments have shown, however, that when magnesic chloride and calcium carbonate mutually react upon each other, soluble calcium chloride and magnesium are formed; this explains why calcium carbonate is never found, except in very small quantities, in marine boiler deposits. When distilled water only is used, a slight coating is formed, practically consisting only of organic matter, whilst, if at any time, through a breakdown in the distilling apparatus sea water is mixed with the distilled water, a thin and very hard scale of calcic sulphate is formed. An incrustation of this character gave on analysis: Calcic sulphate, 90.84; magnesic hydrate, 0.75; sodic chloride, 1.41; silica, 0.85; copper carbonate, 1.11; oxides of iron and alumina, 0.24; organic matter, 2.96; moisture, 1.84; total, 100.00. This scale is of great interest from the presence in it of the carbonate of copper. It is well known that distilled water has a far greater solvent effect upon metals than a water containing salts in solution, and it is quite conceivable that the distilled water from the surface condensers attacks the brass and copper tubes and fittings, and deposits the copper on the tubes of the boiler, although in only small quantities; and it is interesting to note that the green spots due to the presence of the copper are all on the under side of the scale—that is, in contact with the metal of the boiler tubes—showing that in all probability it had been deposited, as suggested, from the water in the boiler, and in contact with the iron would set up local galvanic action, and tend to produce pitting.—*The Engineer* (London).

Record of One Day's Run of the City of Paris.

The fastest day's run made by the City of Paris during her last passage was five hundred and fifteen miles; this is the fastest day's run ever made by a vessel on a transatlantic voyage. Had it not been for adverse winds, the City of Paris would probably have made the whole passage in less time, and broken her previous record.

Modern Locomotive Construction.

BY J. G. A. MEYER.

NINETY-THIRD PAPER.

The objection raised to the throttle lever, shown in Figs. 516, 517 (last paper), is that the pitch of the teeth on the arc *B* will limit the degree of opening of the throttle valve, and in some cases will not be as close to the requirements of the engine as may be desirable. Again, on account of the fine pitch of the teeth in the arc *B*, strength, and consequently security, will be impaired; and also in some cases the wear of the teeth is objectionable.

Figs. 518, 519 represent a throttle valve lever, designed to overcome these objections. In this arrangement a curved rack *B*, instead of an arc, is introduced; the rack is placed under the lever *A*. This rack engages with a small pinion *C*, keyed to the stud *D*; to the same stud is keyed another wheel *E*, larger in diameter than the pinion; the wheel *E* is an internal spur wheel, whose teeth engage with the link *T*, preventing the stud *D* from turning, and thus locks the throttle lever in the desired position. The reason for placing the teeth inside of the wheel *E* is simply to obtain a pleasing effect, exposing to view plain and polished surfaces, which can be kept clean. The link *T* is connected to the handle *R*, the spring *S* holds the link *T* in contact with the teeth in the wheel *E*. In pressing the handle *R* towards the throttle lever handle, a disengagement of the link *T* and the wheel *E* takes place, enabling the engineer to move the throttle lever to and fro with ease.

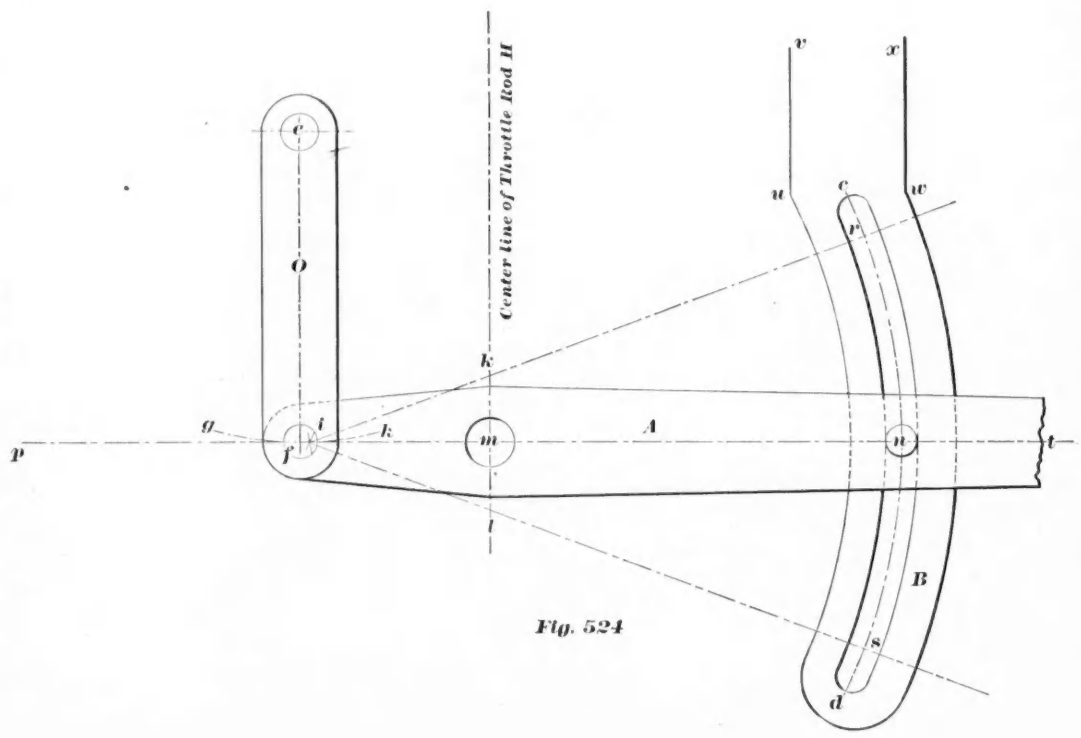
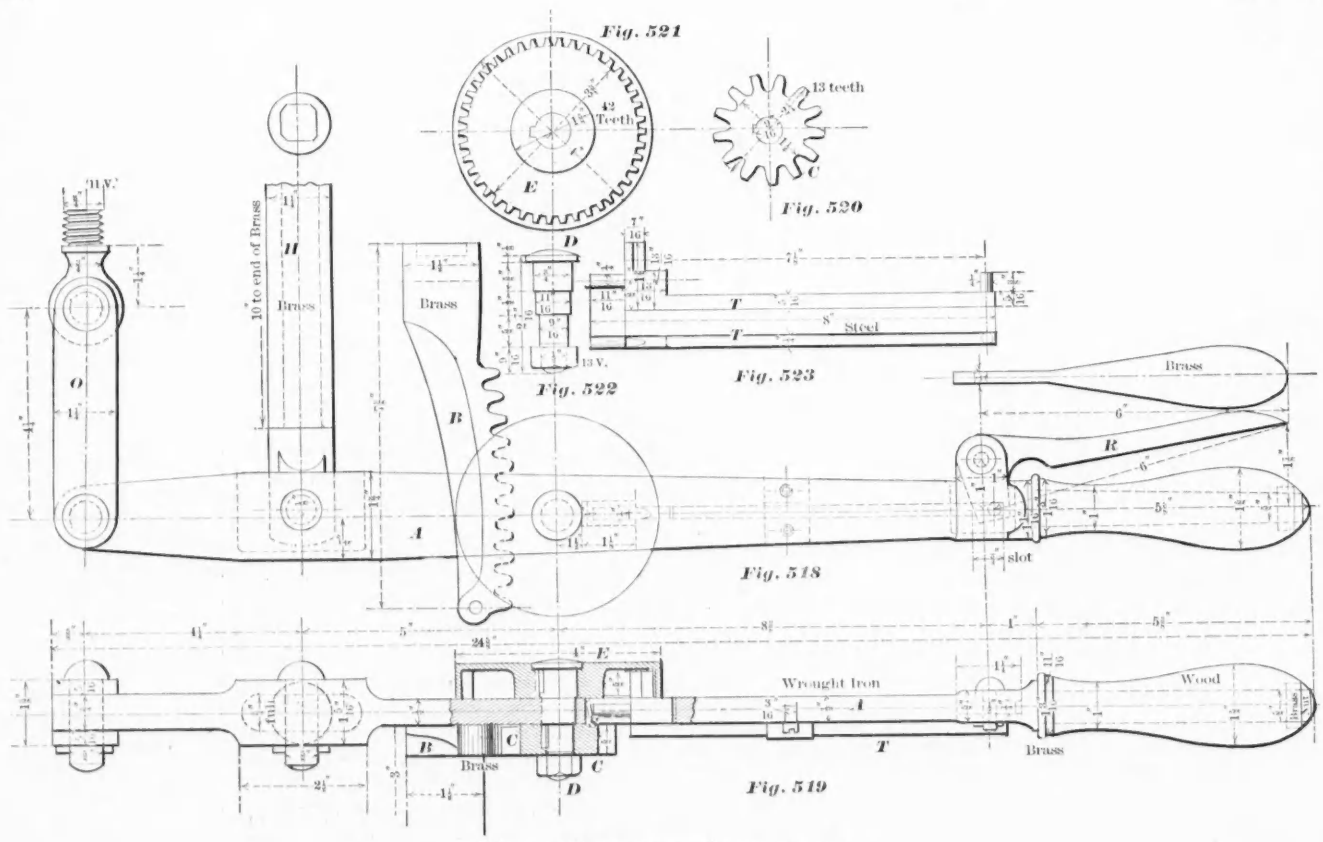


Fig. 524



MODERN LOCOMOTIVE CONSTRUCTION.

In this arrangement the wear of the teeth in the rack will be less than the wear of the teeth in the arc shown in Fig. 516; also, because the pitch of the teeth in the rack and in the wheel *E* are greater than the pitch of the teeth in the arc *B* (Fig. 516), the strength of this arrangement and security will be increased. A very close adjustment of the throttle valve to the requirements of the engine can also be obtained; indeed, this closeness of adjustment largely depends upon the difference between the diameters of the wheel *E* and the pinion *C*. For instance, suppose that the pinion *C* makes just one complete turn in lifting the throttle valve one inch, then the wheel *E* must of course also make one complete turn during the time the throttle valves lift one inch; if now the wheel *E* has 42 teeth, then it must be obvious that the throttle valve can be set to $\frac{1}{42}$ of an inch; and if a closer regulation is required without changing the pitch of the teeth in the wheel *E*, then we have only to increase its diameter so as to enable us to increase the number of teeth.

The method for finding the length and curvature of the pitch line for the rack *B* is the same as that for finding the length and curvature of the arc *B*, in Figs. 514 and 516 (last paper). In order to explain this method, we have shown in Fig. 524 a portion of the throttle lever *A*, the links *O*, and a portion of the arc *B*. Before we can determine the length and curvature of the arc *B* we must know the lift of the throttle valve; hence the following problems present themselves: first, to find the lift of the throttle valve; second, to find the length of the arc *c n d*; third, to find the radius of the same arc.

First, to find the lift of the throttle valve. To explain this, we shall refer to Fig. 504 (ninety-first paper). In this figure we see that the smallest inner diameter ($4\frac{5}{8}$ inches) of the throttle pipe is at the bottom of the pipe; the area of a circle $4\frac{5}{8}$ inches diameter is 16.80 square inches; hence the throttle valve must have a lift which will allow such a quantity of steam to enter as can pass through an area of 16.80 square inches. Again, we see that the valve seats are of a conical form; but, for the sake of simplicity in finding the lift, the valve seats are assumed to be flat. Under these conditions the lift of the valve must be such that, when the circumferences of the inner edges of the valve seats are multiplied by the lift, the area thus obtained will be equal to the smallest inner cross-sectional area of the pipe, which in our case is 16.80 square inches.

In Fig. 504 we see that the diameter of the inner edge of the upper throttle valve seat is $4\frac{1}{2}$ inches, hence its circumference will be $4.5 \times 3.1416 = 14.13+$ inches; the diameter of the inner edge of the lower valve seat is 4 inches, its circumference will be $4 \times 3.1416 = 12.56+$ inches; the sum of the two circumferences will be $14.13 + 12.56 = 26.69$ inches; hence in the case before us the lift will be $\frac{16.80}{26.69} = .62+$ inch. But this lift is suitable only for flat valve seats, and will not give us a sufficient opening for conical valves. In nearly all locomotives the inclination of the valve seat varies but little from an angle of 45 degrees from the axis, and therefore we will generally obtain good results by adding 50 per cent. to the lift just found; hence the lift for the valve shown in Fig. 504 should be $.62 + .31 = .93$ inch. From the foregoing we may establish the following rule:

Rule.—Divide the smallest cross-sectional area of the throttle pipe by the sum of the circumferences of the openings in the valve seats; add 50 per cent. to the quotient; the sum will be the lift of the valve. If now the lengths of the arms of the bell crank to which the valve stem and throttle rods are connected had been equal, the throttle rod *H* would have to move through a distance of .93 inch. But in Fig. 504 we see that the arm of the bell crank to which the valve stem connects is $2\frac{1}{2}$ inches long, and the other arm is 6 inches long, hence the movement of the throttle rod will be $\frac{6}{2\frac{1}{2}} = 2.4$ times greater than the lift of the valve; and if the lift of the valve is .93, then the total movement of the throttle rod will be $2.4 \times .93 = 2.232$ inches, say $2\frac{1}{4}$ inches.

Second. To find the length of the arc *c d*, Fig. 524.

To make the solution of our problem as plain as possible, let us assume that Fig. 524 is a portion of the throttle work, as shown in Fig. 514.

Draw the center line *k l*, of the throttle rod *H*, and on it lay off two points, *k* and *l*; the distance between these points must be equal to the travel or movement of the throttle rod; if this travel is to be $2\frac{1}{4}$ inches, as found by the foregoing calculations, then make the distance between *k* and *l* equal to $2\frac{1}{4}$ inches. When the throttle valve is one-half open, or, in other words, when it stands in the center of its lift, the center line *p t*, of the throttle lever *A*, stands generally parallel to the back end of the boiler and the center line *e f* of the link *O* stands perpendicular to *p t*, as shown in (Fig. 414.) Under these conditions, draw through the center *m* (Fig. 524), of the movement *k l*, a line *p t* perpendicular to *k l*, and a line *e f* perpendicular to *p t*, cutting the latter in the point *f*; the distance between the lines *k l* and *e f*; must of course be equal to the given distance between the center line of the link *O* and the center line of the throttle rod; in Fig. 514 we see that this distance is 3 inches. The point *f* will be the center of the pin through the end of the lever *A*, and the point *m* will be the center of the pin through the lever *A* and the throttle rod *H*. On the line *p t* lay off a point *n*, and make the distance between *m* and *n* equal to the given distance between the center of the pin *m* and the center of the clamping bolt; in Fig. 513 we see that this distance is $6\frac{1}{2}$ inches. Now, the center *e* in the link *O* will be stationary, the center *f* will move along the arc *g h* described from the center *e*, and the center *m* will move along the straight line *k l*. Therefore from the point *k* as a center, and with a radius equal to the distance between *f* and *m*, describe a short arc, cutting the arc *g h* in the point *i*, join the points *i* and *k* by a straight line, and prolong it towards *r*. Again from the point *l* as a center, and with a radius equal to *f m*, describe a short arc cutting the arc *g h*; the point in which these two arcs intersect will very nearly coincide with the point *i*, previously found; for all practical purposes we may assume these points do coincide. Through the points *i* and *l* draw a straight line, and prolong it towards *s*. Make *k r* equal to *m n*; also make *l s* equal to *m n*.

When the throttle valve is closed, the center line of the throttle lever *A* will coincide with the line *i r*, and the point *r* will be the position of the center of the clamping bolt. When the throttle valve is full open, the center line of the throttle lever *A* will coincide with the line *i s*, and the point *s* will be the position of the center of the clamping bolt. The arc *r n s* will represent the length of the path of the center of the clamping bolt. In practice it is customary to make

the arc r n s about one inch longer than length just found, consequently the length of the arc c n d will be equal to the sum of the arc r n s, as found by construction, plus the diameter of the clamping bolt, plus one inch.

Third, to find the radius of the arc c n d. This arc will not coincide exactly with an arc of a circle, yet the difference is so slight that it may be neglected, and for all practical purposes we may assume that the arc c n d is an arc of a circle. Now, the points r, n, s are points in this arc, hence all that is necessary is to find a point p, from which an arc can be described which will pass through the three points r, n, s; the distance from p to any one of these points will, of course, be the required radius.

Probably the quickest way to find the point p is by trial; it can also be found in a geometrical way, as explained in Problem 12, Practical Drawing, AMERICAN MACHINIST, January 8, 1887.

The lines u v and w x extend and are perpendicular to the back head of the boiler; the distance between the center line of the throttle rod H and the line u v will depend on the position of rivets in the head of the boiler, and this distance should be so adjusted that the stud, or studs which fasten the arc B to the boiler will be clear of the rivet heads.

Foundry Clamps.

BY ROBERT E. MASTERS.

To clamp a flask right is one of the important points about the production of good castings; yet how little thought some moulders apparently give it. We see evidences every day in "run-outs," "shifts," "drop-outs," "shut-offs," etc., etc., of how flasks ought *not* to be clamped, and of some of these I propose to speak, and hope in some measure to remedy the evil. I am talking now of ordinary work, where from six to a dozen or more flasks are put up on a floor in a day, and on which from two to eight clamps and wedges, as shown in Figs. 1 and 2, are used.

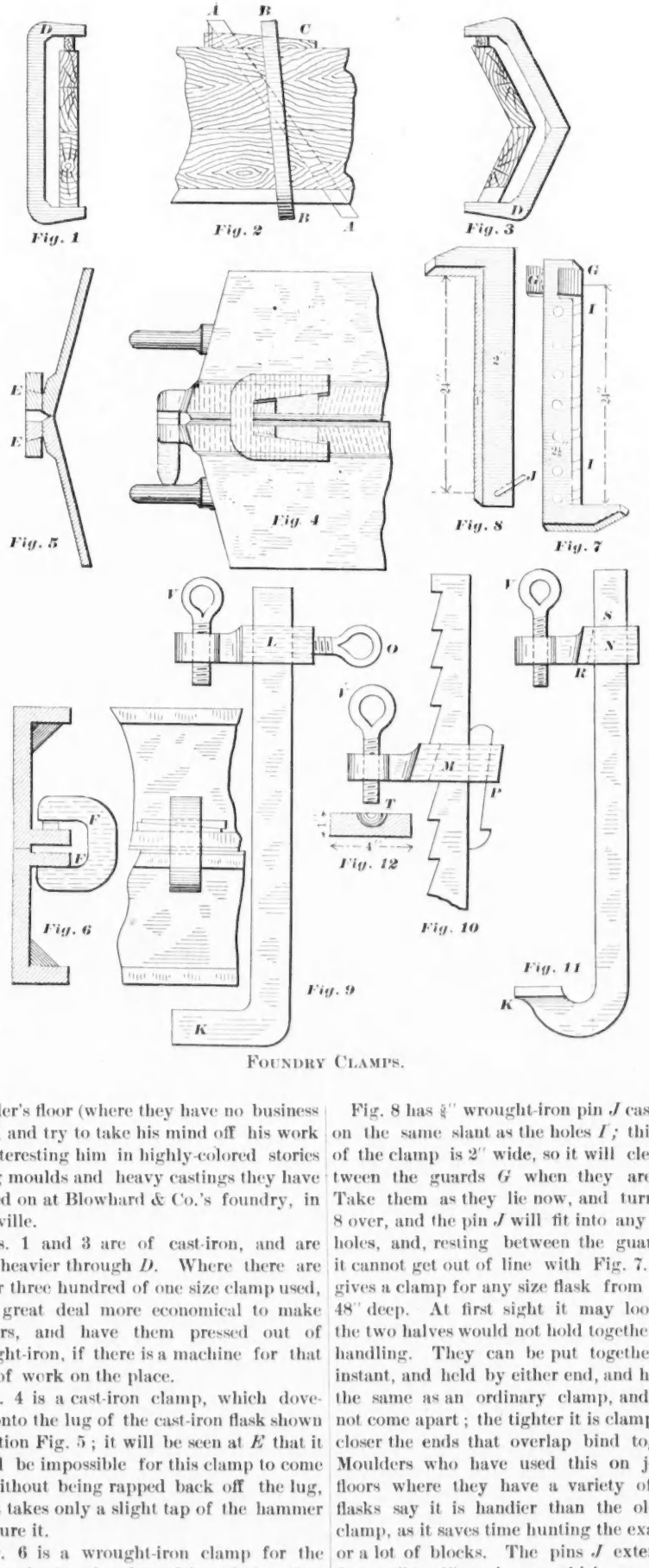
If any one touches clamps at such an angle as dotted lines A A, they will fall off; they do not hold very much if they remain on, and will drop away at the bottom from their own weight when a little strain comes on them, and a "run out" is the result. Then there is the complaint, "somebody knocked the clamps off my flask." Time would be profitably spent in finding shorter clamps and drawing them on securely, as at B B.

A flask shifts, and time is not taken to repair it, or to tighten the plates and pins. The cope is put on, rammed up and closed "sun about," then the clamps are put on in the *opposite* way to "sun about," and all leaning in the same direction. Clamps should never all lean the same way; even if there are only two on a flask, the one opposite B ought to lean the reverse way.

A green sand mould is closed which has some delicate projections hanging from the cope side. The clamp is pitched the same angle B, but instead of drawing the clamp onto the wedge C gently and snug with a clamping bar, the wedges are put in the reverse way to C, and pounded in with a hammer, some of the hanging sand drops off—result: a bad casting—echo: "Wonder what did that! guess somebody must have struck one of the gaggers."

Some thin castings are wanted—the drag is put down on the "follow board," rammed up, struck off, and then a lot of loose sand is thrown over this, and the bottom board put on so that there is a space of $\frac{1}{2}''$ or more between it and the drag. (It would be worth the trouble to rub the bottom board down firmly.) The drag is turned over with perhaps one clamp on the rolling side; we can imagine the loose sand stays right where it is put. But it don't. To clamp the flask together while ramming up the cope would take too much time (and come too near insuring a good casting); so the clamping is omitted until the mould is dressed and flask closed. The clamps are all drawn on one side of the flask, first with a long clamping bar at about two tons pressure, until the bottom board has been drawn jam up to the flask (where it ought to have been in the first place), then, on going around to clamp up the other side, the joint is found strained open; don't matter, here is a good, strong clamping bar and clamps, and it can be drawn down all right. The result is a shut off casting, and everybody (except the moulder), from the cupola tender to the foreman, is to blame, because "the iron wasn't hot enough to run the casting." It is a safe plan to draw clamps on even all around, and to try them before pouring off, to be sure they are on snug.

This careless kind of work is done by an indifferent class of moulders, who are in a hurry to get clamped up; sometimes flasks are neglected to be clamped entirely, so they can sit down and smoke their pipe before the iron comes down, or go over on some good



FOUNDRY CLAMPS.

class,) there ought to be heavier clamps, or more of them, around the bottom flange than is required at the top. These clamps can be made of cast-iron if made heavier in proportion, but they are not so reliable as those made of wrought-iron; sometimes the wrought clamps get cracked at F, and, if they are not inspected, will be put on in a place where it is dangerous to use a defective clamp. They can be easily detected from the sound ones by the ring—swing between the fingers and strike them with a light hammer.

Figs. 7 and 8 is an adjustable clamp invented lately by the writer, and given here for the benefit of any who may wish to use it. Fig. 7 is the same as the half of any ordinary clamp, with guards G at the end, and $\frac{3}{4}''$ holes $2''$ apart; this half is $2\frac{1}{2}''$ wide and $1''$ thick; the $\frac{3}{4}''$ holes are cored through slanting, as indicated by the dotted lines I I.

moulder's floor (where they have no business to be), and try to take his mind off his work by interesting him in highly-colored stories of big moulds and heavy castings they have worked on at Blowhard & Co.'s foundry, in Windville.

Figs. 1 and 3 are of cast-iron, and are made heavier through D. Where there are two or three hundred of one size clamp used, it is a great deal more economical to make formers, and have them pressed out of wrought-iron, if there is a machine for that class of work on the place.

Fig. 4 is a cast-iron clamp, which dovetails onto the lug of the cast-iron flask shown in section Fig. 5; it will be seen at E that it would be impossible for this clamp to come off without being rapped back off the lug, and it takes only a slight tap of the hammer to secure it.

Fig. 6 is a wrought-iron clamp for the flanges of a heavier class of iron flasks; they can be made of $1\frac{1}{4}''$ to $1\frac{3}{4}''$ square iron, according to the work required. If the mould is a deep one (or, in fact, any mould of this

Fig. 8 has $\frac{3}{4}''$ wrought-iron pin J cast in it on the same slant as the holes I; this half of the clamp is $2''$ wide, so it will clear between the guards G when they are cast. Take them as they lie now, and turn Fig. 8 over, and the pin J will fit into any of the holes, and, resting between the guards G, it cannot get out of line with Fig. 7. This gives a clamp for any size flask from $24''$ to $48''$ deep. At first sight it may look as if the two halves would not hold together when handling. They can be put together in an instant, and held by either end, and handled the same as an ordinary clamp, and it will not come apart; the tighter it is clamped the closer the ends that overlap bind together. Moulders who have used this on jobbing floors where they have a variety of sized flasks say it is handier than the old style clamp, as it saves time hunting the exact size or a lot of blocks. The pins J extend out from $\frac{3}{4}''$ to $1''$, owing to thickness of pin, if iron lighter than $\frac{3}{4}''$ diameter is used. If square iron was used, and square holes cast in Fig. 7, it would be even better than round. The pins are so stubby they stand any amount of throwing around without danger of bending. For flasks from $12''$ to $24''$ deep, a set can be made just one-half the length of the one shown, and proportionately lighter; thus two sizes of clamps will fit any depth of flask from $12''$ to $48''$.

Figs. 9, 10 and 11 are three styles of adjustable wrought-iron clamps for heavy work. For instance, if there is a large piece to bed in the floor, lay down the rails, beams or girders, whichever is used (I prefer old rails to anything), put the bottom plates on top of the rail, put the ends K K under the rail so the clamp will come next the cope. When the mould is finished, rails can be laid across the top, and the locks L M and N adjusted to fit.

Either of these is a reliable, handy clamp to use on large wooden or iron flasks; besides binding a class of green sand moulds in the floor, they often come in handy on loam work. The lock L is fastened behind with a set screw O. Loosen the key P, and the lock M can be moved forward, and into whichever notch suits. The hole in lock N tapers inside, shown at the dotted lines R; the leverage obtained by screwing down the set screw V binds the lock at S, so it cannot slip. I used a set (8) of these clamps for a long time; they were out of $1\frac{1}{2}''$ square iron, and often subjected to a heavy strain, yet I never had one to yield; still I prefer clamp Fig. 11, and lock L, Fig. 9; either of these can be turned at right angles with K K if necessary.

Fig. 12 is a section view of a cast-iron plate $4''$ diameter, $1''$ thick, with a recess at T, for the end of the set screws V V V; this plate prevents the set screws slipping off a bar or cast flask, or cutting into the edge of a wooden flask.

Note on Erecting Shafting.

BY W. H. BOOTH.

In erecting shafting of ordinary lengths, it is sufficient that a spirit level should show every part of the length to be level. In a shaft of great length, this method of erecting is not absolutely accurate, but there are few examples where even a long shaft cannot be set up correctly by the level. The curvature of the earth is at the rate of 8 inches multiplied by the distance squared in miles. Thus, a shaft one mile long must depart 8 inches from the earth's curvature, one two miles long would require to be raised at one end 32 inches above its initial point, and would be very badly fixed indeed, if leveled by placing a spirit-level upon its upper side. I have heard it stated that much shafting has been badly erected by reason of neglecting this point, but I am disposed to doubt this; for few lengths of shafting are so extensive as to require the point to be considered. For example, a length of shafting 264 feet long would be very great, and yet the difference between a straight line of this length and a curve of the same length, of 4,000 miles radius, is only $\frac{1}{50}$ of an inch. In a long shaft, therefore, it is always best, when setting up by the level, to start in the middle and work towards the two ends. In abnormally long shafts it is perhaps best to align them by using an engineer's level and sighting a line right through, or a millwright with a good eye may fix point after point, by making each one coincide in direction with two preceding points. Such precautions are not required under 200 feet, and I have chiefly drawn attention to the subject from the fact that ultra particular people have at times dwelt on the question of earth curvature, as if its importance were much greater than it really is.

Those who are accustomed to long shafting may find it difficult to call up many single lengths greater than 200 feet, but it would be of some interest to have particulars of the longest lengths of shafting known, and the method of alignment adopted in erection. Where a long shaft is merely used to transmit power from one point to another, without being required to drive machinery on the way, it is probable that wire rope transmission would be better and cheaper; for, with the

most careful alignment, a long shaft is sure to be more or less out of truth, vertically. Laterally exact straightness may be obtained by allowing the bearings to adjust themselves as they will do if not tight bolted, but exact vertical adjustment is more difficult to secure, because, even if below a proper level, the weight of a shaft keeps it down to a bearing, and does not permit its limited stiffness to lift it clear of a brass that may be $\frac{1}{32}$" too low, though in a straight shaft a thirty-second out of adjustment laterally would be at once self-corrective on loosening the holding down bolts of the pedestal.

Details of Sweet's 16-Inch Engine Lathe.

BY PROF. C. I. KING.

II.

In Fig. 9 a half plan is shown of the surface of the bed on which the head stock rests, with a longitudinal section through the train of screw cutting gears, represented in Fig. 10. The curved T grooves at the head end and corner of this surface receive the bolts by which the head stock is fastened in place. The shaft S is the continuation of S', shown in Fig. 1 of previous article, and fits in a square hole in the gear g. The gears g' and g'' each revolve loosely on the shaft S', a steel cam C being fast to it. This shaft has an end movement sufficient to allow the projections on either side of the cam to engage with the counterparts on either gear, and so imparting motion to S' in either direction.

Special attention is called to these clutches—as screw cutting by this lathe can be done by reversing the screw instead of reversing the lathe, it is imperative that the clutch or shaft should make a complete revolution, or, in other words, always assume the same relative position with the upper shaft when thrown in gear, that it has before; or to explain, assume that a threading tool is in a half-finished thread, and the clutch thrown out; then, when thrown in again, it must take the same position, in order that the tool shall be correctly set. This heretofore has been accomplished by using a single tooth clutch. But a single tooth clutch is objectionable, as it tends to twist the gear to one side and wear it out of truth. In the clutch here used, there are two teeth on opposite sides in contact, and yet the shaft makes a complete revolution; that is, always takes the same position when thrown in gear, whether running forward or back.

This movement of the clutch shaft S is caused by the half ring r, which is connected to a handle within reach of the operator. On this shaft are two sleeves s_1 and s_2, the inner one having a key fitted in a spline in the shaft, the spline extending to the outer end. This sleeve is also connected with the outside one so as to drive it positively, a slight end motion of the sleeve s_1 being provided for to allow clamping. The inner end of the sleeve s_2 terminates in a cone C'', while the inner corner of s_1 is chamfered to fit it.

This sleeve is also cut in four parts for four inches back from the chamfer, so that when forced against the cone C'', the end E expands into the gear with sufficient force to drive it. The sliding of one sleeve on the other is caused by turning the star nut N, in which two threads are cut, one of 12 and one of 16 pitch. These sleeves can be drawn out to clamp any pair of gears in the set. The lower shaft and sleeve are similar in action to the other one, though one sleeve is dispensed with, and the shaft and sleeve are drawn out together in setting for any pair of wheels. On the lower shaft, just outside of the frame which carries the screw wheels, are three other gear wheels, W, W', W'', one of which is cut on a steel sleeve S_3, the two others being keyed to it. It also has two keys, which extend into the splines in the sleeve S_4, which, being driven by one of the gears of the train, causes the three wheels to revolve with it. The sleeve S_3 is supported in place by a second sleeve put in from the outside, and which also forms the bearing for S_2. Eight rings are marked on each of the sleeves, one for each wheel, the distance between each ring equaling the length of the wheel hubs. These rings are divided into three parts, and at each intersection is stamped the number of threads to be cut in that position, one set of wheels cutting three different screws by means of the three wheels W, W', W'' in combination with three wheels on the main screw.

The method of holding the screw gears in place is shown in part by Fig. 11, which gives an end elevation of the first plate through section A B, with dotted outline of the intermediate plate. This first plate extends up to the bed and is bolted fast, as shown at B, Fig. 2, and b b, Fig. 3. A plan and edge view of the intermediate plates is shown at Fig. 12. The terminal plate at the opposite end is seen at Fig. 13. It carries one of the bevel wheels g'', Fig. 10, and also has two end hubs H, against the end of which the cast piece shown in two views at Fig. 14 is placed. This casting also serves as a journal box for gear g', Fig. 10; the two set screws s s, setting up against the projection P, on the inside of the bed (section C D) gives slight side adjustment, while screw S', Fig. 10, carries the weight and gives the vertical adjustment. Two bolts, one on each side, pass through the hubs of all of the plates, fastening them firmly together. The pin p, projecting from the hub H, Fig. 13, serves as a pivot for the reversing arrangement. The hubs of the screw wheels project far enough on each side to go half way through the larger hubs of the plates, while the bolt hubs project far enough beyond the large ones to allow their surfaces to come together, and yet to allow room for the wheel webs, so that the wheels turn freely, while the plates are fastened solidly together.

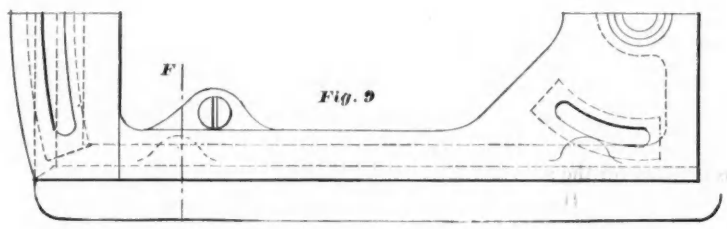


Fig. 9

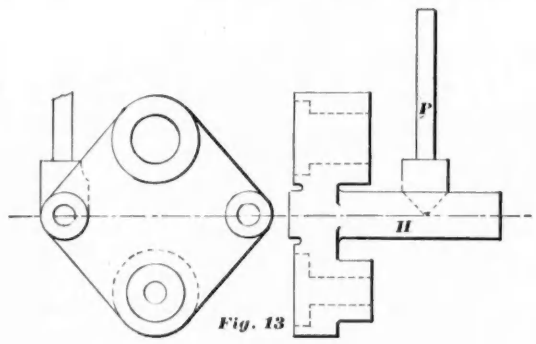


Fig. 13

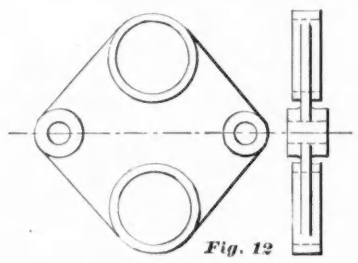


Fig. 12

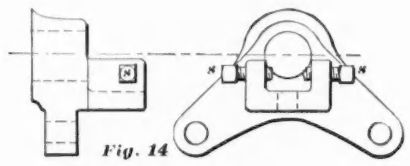


Fig. 14

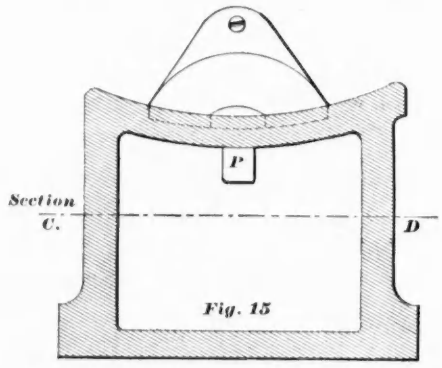


Fig. 15

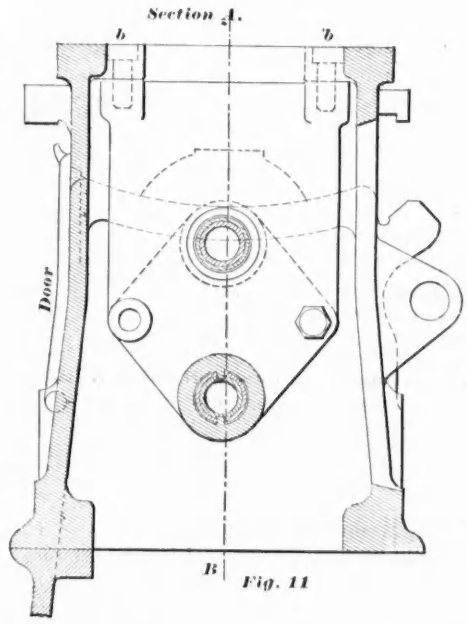


Fig. 11

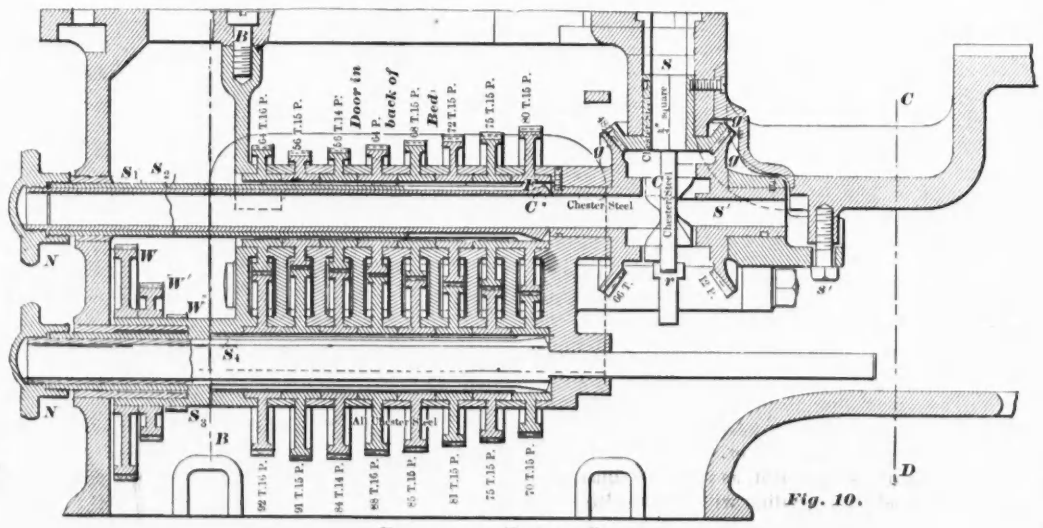


Fig. 10.

DETAILS OF ENGINE LATHE.

LETTERS FROM PRACTICAL MEN.

Shrinkage of Steel.

Editor American Machinist:

Your remarks upon steel, and others, that have told of their troubles, working steel they were not quite sure of, calls to my mind an experience I once had with a tap made from a piece of steel of which I knew nothing, except that some of it had made some excellent cold cutters for blacksmiths' use. In repairing some machine it was necessary to make a new wrought-iron nut, some 7" long through the hole, and oblong, with pivots in cross-section. The bolt on which this was to go was of machine steel $1\frac{7}{16}$ in. diameter, with six half V threads to the inch. The nut was chuck drilled and a thread cut in it as well as we could do with so long an inside tool. I then made the tap for smoothing out the nut, as it must be a straight thread and tight fit. The bolt, nut and tap were made on the same lathe and with the same gears. The tap was finished and tempered, and was apparently all right, as it worked nicely in some test pieces of both cast and wrought-iron, about $\frac{3}{4}$ inch thick and they fitted the screw good and tight. On attempting to force it through the nut that was already cut nearly to size, it got scored, and finally some of the threads crumbled and it could not be got out. I cut the nut open in a planer, and then noticed that the threads did not match each other, and on careful measurement I found that the threaded part of the top, that was 5" long, was 5-100 inch shorter than it should have been, and on matching it beside the bolt only three or four threads would mesh together. Another piece of steel was procured upon special order, which did not show any permanent shrinkage in tempering, and a nut was made in just the manner that was attempted at first.

PETER H. BULLOCK.

Albert Baker's Boiler.

Editor American Machinist:

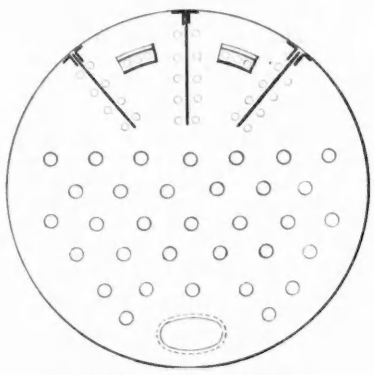
Mr. Baker (April 4) wants your readers' opinion on his boiler heads. My opinion is, first, that if of originally good iron, he may dismiss any idea of their being crystalline. As an Englishman, my ideas may not commend themselves to Mr. Baker, but I will give them for what they are worth. Bar stays placed—as I suppose from his question they are placed—*i. e.*, diagonally, and attached by one rivet to head and one to shell, are poor things, and not to be trusted to carry the high pressures employed in America. However, quite apart from this question of pressures, which are as excessive in America as the customary English pressures are unnecessarily low, I should advise the removal of all such diagonal bar or palm stays, and the substitution therefor of plate gussets, attached to both shell plates and heads by double angle irons. The angle irons should be, say, $2\frac{3}{4}$"x$2\frac{3}{4}$"x$\frac{7}{16}$", and the gusset plate, say, $\frac{5}{8}$ inch; and as many rivets should be used to each angle iron on the head as on the shell. The shell and head rivets are in single shear; but the rivets through the gusset plates, being in double shear, have equal strength, though fewer in number.

For a boiler of 90 inches I would use five gussets, this diameter of boiler being standard in Lancashire; but for a 52-inch shell I should be disposed to use three gussets—one central and vertical, and the other two about equally dividing the arc between the vertical and the upper tube level.

As to attempting to flatten out the heads, I would never attempt this, but simply attach

the stays in a good sound manner, and leave the slight bulging alone.

The advantage of a gusset plate stay is the support which it affords along a line, rather than at a point, as does the bar stay. One precaution is needed—the gusset angle irons must not come too closely down to the tubes, or the plate will be held too rigidly, and may commence to groove. Some boiler makers will stiffen the end plates in portions between the gusset stays, by riveting short bits of angle iron so as to form a ring con centric with the shell, as shown in Fig. 1, which approximately embodies my ideas of boiler staying. Generally speaking, the stresses taken up by boiler stays should be communicated through as great an area at possible; shell and end plates of boilers are quite sufficiently punished, without being required to take up any further stresses as points of cencentration.



ALBERT BAKER'S BOILER.

Finally, I would point out that, where a boiler head returns to its original position, after removal of stress, the staying is likely to be not far wrong. I myself never yet saw a boiler whose head would not bulge more or less under pressure; and for most boilers it is essential they should do so, for the tubes are always longer than the shell when at work, if of the same length when cold, owing to the greater effect of the fire upon them. This last remark, of course, applies to internally fired boilers, not to shell bottoms set over an external furnace.

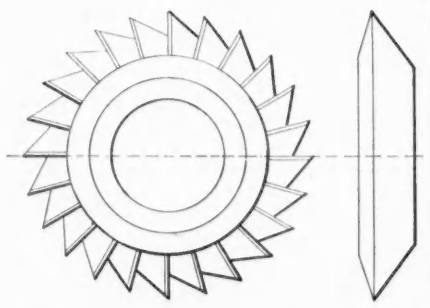
London, England. W. H. BOOTH.

Taper Side Angle Mills for Cutting Any Spiral.

Editor American Machinist:

The above mills differ from the so-called "Regular Angle Mills" in that one side is slightly tapered for clearance.

Every machinist is aware, when cutting a screw, that the cutting tool requires an adaptable amount of clearance; just so in spiral milling. The shape of the cutting tool being circular, it becomes important that the work should be set at the proper angle to the mill, to insure good smooth milling.



The following rules for arranging work for milling will be found easy of comprehension:

1. To obtain the proper height of centers of machine under the mill, subtract from half the diameter of work the depth of cut it is desired to mill, which is the proper height. Hold a short straight-edge against the lower side of mill where the teeth are cut, and move the centers of machine vertically until the inside of straight-edge coincides with centers.

2. To dispense with any tables of nat. tangents, cotangents, etc., which are not always at hand, the following method, to ascertain the proper spiral for any given angle will be found practically correct: Divide 360 degrees by given angle; multiply the product by diameter of work to be milled, divide by 2, and from this subtract ½ inch; this gives spiral wanted.

Example: Diameter of work to be milled, 3 inches; given angle, 15 degrees.

360 deg. divided by 15 = 24 ×
3 = 72 divided by 2 = 36.00 inches.
subtract 0.50 "
35.50 inches.

Compare this example with the "Technical Formula," and the result is nearly the same:

Circumference of 3 inches = 9.4248″
Nat. Tangent of 15 deg. = 0.2678 = 35.18″

As will be seen by the above examples, the first one results in a spiral 32 one-hundredths of an inch slower than the second, a favorable result for the mill, to prevent it from dragging.

At some future time I will give an easily understood method for obtaining any combinations of gears for the above.

CHAS. H. MALMEDIE,
Foreman Morse Twist Drill & Machine Co.
New Bedford, Mass.

Tool Room Devices.

Editor American Machinist:

A handy device for the tool room consists of a block of wood, bored for the reception of the shanks of a set of taps, drills for body and tap size and counterbore or countersink.

It saves time, in requiring but one check, prevents liability of mistakes in selection of drills, and allows the condition of each article to be readily seen on return.

An improvement in Y centers has been found convenient to the writer, and to effect a saving in drills when used on round work, by having the part *A*, next the work, turn or swivel on that portion entering spindle.

W. E. W.

Grease for Crank-Pins.

Editor American Machinist:

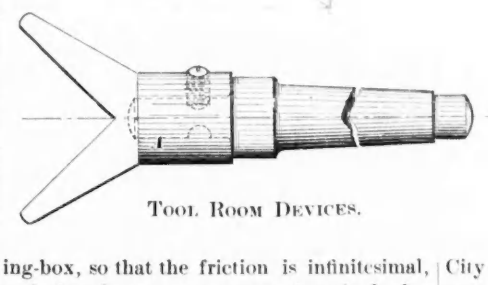
I notice that, at the last meeting of the A. S. M. E., one of the topical discussions was upon the use of grease on crank-pins. Some of the members seemed to doubt its practicability. In these works we have twenty-nine cases of steam engines, having their crank-pins lubricated with grease, and are very well satisfied with the result. Some of these engines will indicate 500 horse-power, and some run 150 revolutions per minute. In a comparative test of lubricating steam engines with grease or oil, I found that the former was more satisfactory as a lubricant, and cost only one-fourth as much as the latter. The cleanliness of the grease is also very much in its favor.

R. H. DAVIES,
M. M. Phœnix Iron Works.
Phœnixville, Pa.

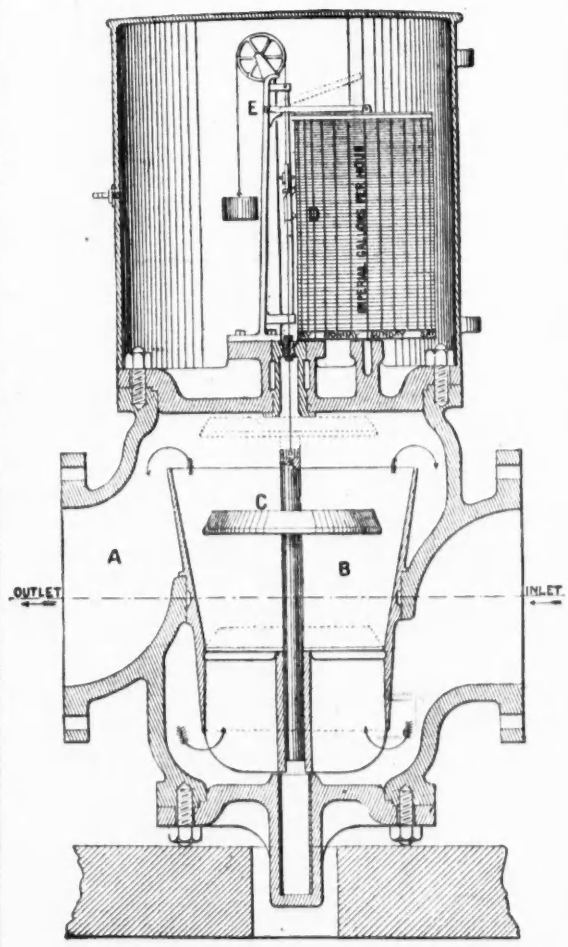
Deacon's Water Meter.

[For the description of this meter, and the engraving which we reproduce, we are indebted to *The Engineer*, London.]

The water meter shown by the accompanying section is a development of the meter devised by Mr. George Deacon, engineer to the Liverpool water-works, for constantly registering the flow of water through street mains and house pipes, thus permitting of the ready detection and localization of any waste that might otherwise go on indefinitely without being observed. But, as the form illustrated is intended for dealing with large volumes of water, such as the supplies from reservoirs to trunk mains and the compensation water to rivers, there is no occasion for the very minute measurement and registration which are afforded by the waste water meter. Accordingly, the parts are fewer, and the arrangement is simpler. The body *A* affords a seat for the fixed hollow cone *B*, which, in this form of the Deacon meter, is inverted. The socket affords a guide for the spindle of the disk *C*, the highest and lowest positions of which, corresponding with the maximum flow water and complete closing respectively, are shown by dotted lines. Attached to the top of the spindle is a fine wire passing through a stuffing-box and over a grooved pulley, and kept taut by a small weight. This wire carries the metallic pencil carriage *D*, which rises and falls with the disk, and thus marks the rise and fall of water on the paper wrapped round the drum. As the latter is made to revolve by clock-work, and the paper is ruled with divisions for days, a complete diagram of the flow of water within a given period is the result, while the exact rate of flow at any instant is recorded in a convenient manner. The clock is made of inoxidizable metal—except the main spring, which is enclosed in an air-tight case—and is generally set for a week, but may be arranged for giving a month's registration. The plate which forms the upper bearing of the drum spindle is hinged at *E*, so as to permit of the ready removal of the drum for changing the diagram papers. While the body of the meter with its two covers and the drum case are of cast-iron, all working parts are of gun metal; and the only rubbing surfaces are the spindle in its guide, and the wire in its stuffing-box, so that the friction is infinitesimal, and therefore accuracy not impaired, being equally great at the lowest and highest quantities. The loss of head is so slight as not to be indicated by an ordinary Bourdon gauge, being only 1 in 70. No other meter gives so analytical a registration of the flow as this does, which has been made up to 24 inches in diameter at the inlet and outlet, though the size exhibited is only 12 inches in diameter, the largest size of meter except the Deacon hitherto made. One of these meters is used in Paris by the Compagnie Générale des Eaux, and another has been sent to a provincial town of France. The instrument, all the parts of which are interchangeable, is made by the Waste Water Meter Company, Liverpool, which is now migrating to larger works.



TOOL ROOM DEVICES.



DEACON'S WATER METER.

The Pumping Machinery on the City of Paris.

While the City of Paris embodies in its construction many novel features, and some departures from previous marine practice, none has attracted more general attention in England than the fact that she and her sister ship, the City of New York, are both fitted out completely with the well-known Worthington duplex pumps.

In all English practice hitherto the boiler feed pumps have been a part of the main engine, and worked from levers connected directly therewith. Their action has been more or less unsteady, and the strain brought upon the pumps directly, and to some extent upon the engine, has been such as to bring about, at times, results more or less disastrous.

So long ago as 1884, when the America, constructed by the builders of the Paris and New York, Messrs. Thompson, of Clyde Bank, Glasgow, and the Oregon, built by the well-known firm of John Elder & Co., of Glasgow, both left New York on the same day, much interest was developed in the trial of speed, which all initiated knew would follow. The Oregon made the Fastnet Light first, beating the time of the America by only five hours; but the America lost twelve hours by the breaking of one of her pumps, which occurred by the racing of the engine. This is liable to occur on any steamer and all steamers where the pumps are a part of the engine.

The City of Paris, as well as the City of New York, and also the City of Berlin, are equipped throughout with Worthington pumps, and the main boiler feed pumps on each of them are independent of the main engines. As each of these ships are furnished with triple expansion engines, and carry a constant boiler pressure of from 150 lbs. to 160 lbs. to the square inch, and in the case of the two former ships develop upwards of 20,000 indicated horse-power, the boilers are large, and it becomes a necessity to reheat the feed water to a temperature of from 275 deg. to 320 deg. Fah. This is accomplished by taking the water first from the hot well to a closed heater, in which a live steam jet is introduced directly from the boilers, and the water reheated. Thence it is pumped directly to the boilers. Both pumps are controlled by a device which regulates their speed to the available supply of water in the hot-well, which is not at all times constant.

The quiet, uniform motion of the Worthington pumps can be appreciated perhaps better in this service than in almost any other in which they have been placed. The reports of the engineers of the City of Paris are that in the rough weather incident to her first stormy voyage across the Atlantic, when at times it became necessary to slow down the main engines on account of racing, the pumps named kept on the uniform tenor of their way, and required little or no attention at the hands of the engineering staff. This fact was appreciated at the time, and will be appreciated by all engineers who have passed any time in the engine-room of an Atlantic liner.

There are sixteen Worthington pumps on the City of Paris, the same number on the City of New York, and nine on the City of Berlin.

The White Star steamers Teutonic and Majestic are both equipped with Worthington pumps.—*The Practical Engineer.*

The Engineer (London) calls attention to the fact, that "if a thin india-rubber ball—one of those sold as balloon balls in the toy-shops—be blown full of air, and then held in the hands as the air is allowed to escape, its temperature will be found to fall, so that the difference is very perceptible to the hands as the fall takes place, more especially when complete emptiness is approached."

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NEW YORK, JUNE 13, 1889.

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The Demand for Better Pavements.

It is gratifying to note that there seems a growing sentiment in favor of some sort of pavement for the streets of New York, not open to the serious objections which attach to the use of the present almost universal granite blocks.

That no other pavement can be made to stand the traffic of this busy town, we do not for a moment believe, but we do believe that, if the actual cost to the citizens of the place, resulting from the extra expenditure of force and energy imposed by the present abominable pavements, and of the extra wear and tear imposed upon the hundreds of thousands of vehicles, and upon the nerves and tympanums of the millions of people who must exist and do business in the midst of the all-pervading and deafening roar could be summed up and its amount stated in concrete form, there would be a very vigorous movement towards the securing of some more satisfactory pavement.

The best idea of the abominable character of our present pavements may be had by standing at the corner of Nassau and Liberty streets for a few minutes. A large and fine insurance building stands here, and surrounding it is a pavement which is as smooth and level as a floor, over which vehicles of all kinds roll continuously, and practically without noise, the only sound heard being the fall of the iron-shod hoofs of the horses. Stand there and watch a heavy truck as it rolls along; there is no violent knocking or vibration, the component parts of the truck, the harness and the driver are in no danger of being separated by the violent concussions, and the load is drawn with the minimum expenditure of energy.

The building surrounded by this pavement is a far more desirable and a far easier place to do business in on account of this pavement. Less energy is expended in making oneself heard and in trying to hear others, and it is possible to do the effective thinking which can be done only in a quiet place.

But, as the wheels of the truck strike the corrugated surface composed of granite blocks—by courtesy called a pavement—immediately there is a deafening roar; not only is there the thunderous noise made by the tires of the wheels striking the granite blocks, but every part of the truck which can rattle, or in any way add to the terrible din, does so, and it is easy to see that the draft of the load is appreciably increased.

Every engineer knows that this noise and vibration is produced only by the expenditure of considerable power; and we believe we speak entirely within bounds when we say that the actual cost of the power consumed in producing this continuous and nerve-destroying roar would pay for and maintain the best pavements which have ever been laid in the streets of any city, to say nothing of the cost for repairs and maintenance of equipment, which would be saved by the better pavements.

We believe that if all the streets of the city were covered with such a pavement as surrounds the Mutual Life building, the increased total load which could be drawn by horses, together with the greater proportionate paying load to non-paying or dead load, would make it possible to transport at least twenty-five per cent. more merchandise through the streets than at present without increasing the number of vehicles or horses. And it is to be noticed that this is almost equivalent to a corresponding increase in the width of streets, many of which are nearly always over-crowded, and utterly incapable of accommodating the traffic which seeks them.

And when this matter comes to be looked into, it will be found that it is no matter of exclusively local concern, but that its effects are far-reaching. The cost of transportation of merchandise within the limits of New York city must be added to, and become a component part of the total cost of the goods to the consumer, and when it is considered what a large proportion of the total commerce of the country flows through this city, and what a powerful influence New York prices have upon prices generally throughout the country, it will be seen that it is a matter which concerns many others besides residents of New York.

May the day soon come when the crude and barbarous granite pavement will be abandoned, not only in New York, but in every other city, and something adopted in its place better fitted to the demands of modern civilization. We believe such pavements will pay in dollars and cents alone, besides what will be gained in other ways, including the greater ease of keeping the streets clean where a smooth pavement is used.

Elsewhere in this issue we publish an article prepared by Prof. Denton in discussion of the paper on "Some Properties of Vapors and Vapor Engines," read by Prof. Wood at the Erie meeting of mechanical engineers. We call particular attention to the table and accompanying explanation, because there is still in the minds of many an idea that there is a possibility of important saving by using—in engines—some other vapor than that of water. An inspection of the table will show the fallacy of such reasoning; and if every one would study it, those who are still working their schemes on a confiding public would have harder lines. We commend this table to our readers. They can use it without the necessity of abstruse mathematical formulas, which were purposely omitted by the writer in preparing the article for the AMERICAN MACHINIST.

The Charity Organization Society of this city, in asking, through the papers, for employment for an Austrian, both of whose hands had been amputated as a result of an accident, states that "The society could doubtless have the man supported in idleness, either by pensions or in an institution, but that would be certain ruin to character. The poison of unearned bread would speedily eat out his manhood." We wonder if the secretary of this society, whose name is subscribed to the appeal, really believes that the eating of unearned bread invariably destroys the character of the eater and eats out his manhood. If such consequences actually do befall from the eating of unearned bread (and cake, etc.), there must be a great scarcity of character and manhood in some circles. There are plenty of people in this town who never earned or produced a single cent's worth of value in their lives, yet who have all the bread they desire, and about all they desire besides bread. And there are people who seem to regard them as about the only ones who really have any character or manhood worth talking about.

Literary Notes.

A COURSE OF INSTRUCTION IN MACHINE DRAWING AND DESIGN, for Technical Schools and Engineer Students. By William Ripper, Member of the Institution of Mechanical Engineers; Assistant Professor of Mechanical Engineering, The Technical School, Sheffield.

This work is intended to provide a course of practice and instruction in machine drawing, and the elements of machine design for technical schools and engineer students, giving exercises preparatory or supplementary to that special training to be obtained only in the works and office of the engineer.

These exercises extend over fifty-two full page plates, commencing with a few examples of simple projection, and advancing to the more difficult examples occurring in actual practice, relating mostly to the details of the steam engine and the lathe; giving working drawings of the slide valve gearing, expansion valves, link motion screw propeller, cylinders, pumps, etc., wheel gearing and other machine details. All the dimensions are marked on the working drawings, to which the student is required to work in making similar drawings.

Besides the full page drawings, a large number of illustrations are given throughout the work for the purpose of assisting the student to comprehend the true character and form of the thing represented.

The preliminary chapters of the book relate to the making of working drawings, shading and coloring finished drawings, strength of material, and the principles of construction and design, giving much useful information of the thing to be drawn, which may be studied with advantage concurrently with the exercise in drawing. Many of the working drawings represent English practice and design.

The work is very neatly gotten up, the plates are excellent, and as a whole, will undoubtedly be appreciated by all interested in machine drawing and design. The book is published by D. Van Nostrand Company, 23 Murray and 27 Warren streets, New York. The price is $7.50.

QUESTIONS AND ANSWERS

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(241) A. E. G., Joliet, Ill., writes: I have some flat pieces of wrought-iron ¼x1¾x12 inches, and want to punch a ⅜ round hole through them, ½ inch from end. How should the bottom of the punch be shaped so as to be least liable to split the iron? *A.*—There are punches made which give better results than the common flat punch. We should select the best punch to be found on the market. If then we failed to get satisfactory results, we should drill the holes.

(242) R. D. C., Waterbury, Conn., writes: Please put me on the track of any information in regard to details of foundry construction. We contemplate erecting a first-class foundry, and I am studying up the subject. *A.*—See Foundry Plant designed by L. C. Jewett, in our issue of November 5, 1887; Foundry Ladles, December 3, 1887; Design and Construction of Machine Shops, Boiler Shops and Foundries, by W. H. Hoffman, January 14, 1888. Besides these there have appeared in our issues many articles on foundry matters, written by practical moulders, giving valuable information. We believe that, by referring to the back numbers of the AMERICAN MACHINIST, you will obtain a greater stock of information on foundry matters than you can obtain in any other way.

(243) Reader, ——, I have an engine 12x12, which I am thinking of turning into a compound by placing a cylinder on top of the 12-inch one. The top cylinder will be 6 inches diameter, and of course the stroke will be 12 inches. Now, what I want to know is: What increase of power will the other cylinder give? *A.*—Changing the engine into a compound, as you propose to do, may not increase the power, as this will depend to some entent on the former cut-off. The work done by a compound engine depends on the size of the large cylinder, and will be the same as that which would be performed in a single cylinder of the same size as the low-pressure cylinder, by expanding to the same extent from a like initial pressure. You can easily calculate the horse-power of these engines, and compare the two. For the purpose of comparison, the mean pressure on the piston must be found; the rule for finding the mean pressure has been given in answer to Question 125, in our issue of March 14, 1889. The advantage gained by compounding the engine is a saving in fuel per indicated horse-power.

(244) J. S. G., Rochester, N. Y., writes: A question in mechanics has arisen here, on which we would like your opinion. There are two rectangular blocks, *A* and *B*, each block is 16 inches wide and 12 inches deep, and each is supported by a force applied to the center of the width. The blocks are subjected to a force acting alternately at the extremities of their width, the latter force acting parallel to the supporting force; each block is prevented from tipping over by a flat guide, fitting into a recess cut into the block, the recess running across the block, or, in other words, the direction of the recess is parallel to the direction in which the forces act. In block *A* the recess is as wide as the width of the block will allow, in block *B* it is comparatively very narrow; in fact, the only difference between the two blocks lies in the width of the recess. Now, one party claims that the blocks will resist equally well the forces acting alternately at the extremities of their width. Another party claims that the block *A* will yield under the given force more than the block *B*. Both blocks are supposed to have sufficient strength to resist the forces, so that strength may be left out of consideration. *A.*—Since the force applied to the extremity of each block acts in a direction parallel to that of the supporting force, and since the distance between the lines of action is the same in both cases, it follows that the side action is the same in both cases, and that the block *A* will not yield any more than *B*.

(245) A. H. G., Cleburne, Texas, writes: I placed an air vessel on suction of pump made of a piece of 4-inch pipe, 8 feet long. I do not see that this has made the pump work any better. The suction is made up of three sizes of pipe, 4, 3½ and 3

inch. The water end of pump is 7½ inches diameter, and we cannot run pump faster than 25 strokes per minute. We pump into a railroad tank, and we have to run pump 9 hours to do what other pumps of less diameter do in 4 hours. I have suggested the following plan as a remedy. I would take a circular tank, closed at both ends, equal in capacity to say at least four times the capacity of the pump barrel. To this tank I would connect suction pipe leading from lake. I would have this tank placed close to the pump, and run a short pipe from tank to pump, as per enclosed sketch. Would you kindly give me your opinion as to whether this would obviate the difficulty, or will you suggest a better way? *A.*—Your plan will have a good effect on the action of the pump; but avoid, if possible, the sharp turns or bends in the suction pipe as shown in your sketch, and make its vertical length as short as circumstances will permit. The successful working of the pump will also depend on the arrangement of the discharge pipe, of which you say nothing. The discharge pipe must also be provided with an air chamber. If, with the proper arrangements of pipes and suitable air chambers, the pump does not work satisfactorily, we should advise you to write to the makers of the pump.

(246) C. N. A., Chicago, Ill., asks: Kindly give a formula for determining the proper amount of effective heating and grate surface required in marine boilers to furnish steam to plain slide valve launch and tug engines, ranging from 5x5 to 14x16 inches, forced draft by exhaust in stack; also what percentage of reduction for natural draft. *A.*—In designing a marine boiler, the first step will be to determine the grate surface. The grate surface depends on the amount of coal to be burnt, and this amount is generally dependent, to a large extent, on the quality of the coal, and also on the type of engine which takes steam from the boiler. For surface condensing engines, working at full power, using steam at 30 pounds above the atmospheric pressure, the consumption of good coal per hour will be about 4 pounds per I. H. P.; for similar engines of the best make and large size, about 3¼ to 3½ pounds of coal per I. H. P. will be required; for compound engines of moderate size, and as generally fitted up for mercantile marine service when working at full speed, 2¼ pounds; for mercantile compound engines, well designed and carefully worked at sea at full speed, 2 pounds; and for triple expansion engines, well designed, using steam of high pressure, the coal consumption may be reduced to 1½ pound per I. H. P. For tug boat engines 14x16, a consumption of 5 pounds of coal per I. H. P. per hour will probably be a good average; and for the smaller engines 5x5, a coal consumption 8 pounds per I. H. P. per hour may be required. With natural draft, good coal, and careful firing, about fifteen pounds per square foot of grate may be burnt; in fact, this amount is probably a fair average. In the first place, let us find the proportions of a boiler for natural draft. To find the grate surface for a tug boat engine 14x16, we shall assume that the consumption of coal is 5 pounds per I. H. P. per hour, and that the engine develops 120 I. H. P. Under these conditions we shall need $\frac{5}{15} = 0.33$ square feet of grate surface for each indicated horse-power; therefore, for 120 I. H. P., the total grate surface will be $120 \times .33 = 39.60$ square feet. The grate area being established, we can find the other proportions of the boiler in the following manner: The bridge wall at the end of the grate should be built to such a height that the area of the passage over it is not less than ⅛ or more than 1-6 of the area of the grate; and when possible, the distance from the top of the furnace to the top of the bridge wall should be sufficient for a man to pass into the combustion chamber. There should be about 32 square feet of heating surface to one square foot of grate surface when iron tubes are used; hence, for our 120 I. H. P. engines we shall need $32 \times 39.60 = 1{,}267.20$ square feet of heating surface. The cross-sectional area of the tubes should not be less than ⅛ of the grate area, and need not be more than 1-6; we believe that 1-7 is a good proportion; hence, for the engine under consideration, we shall require $\frac{39.60}{7} = 5.65$ square feet for the total cross-sectional area through the tubes. The tube surface in single-ended boilers is usually about .8 of the total heating surface, and since we have already found the total cross-sectional area of the tubes, we have sufficient data to find, approximately, the length of the tubes. Now let us consider forced draft. For forced draft, the consumption of coal is of course greater per square foot of grate than with natural draft, and since the forced draft may be made to vary considerably, the amount of coal consumed is also variable. When the consumption of coal is 25 pounds per square foot of grate, or more, there should be allowed about 1.4 square foot of heating surface for every pound of coal burnt. To illustrate, let us again assume that 5 pounds of coal are required per I. H. P. per hour, and that 120 I. H. P. are to be developed, and that 30 pounds of coal are burnt per square foot of grate; then we will require $\frac{5}{30} = .166$ square foot of grate per I. H. P., and the total grate surface will be $.166 \times 120 = 19.92$, say 20 square feet. The total consumption of coal on this grate will be $20 \times 30 = 600$ pounds. Since we are to allow 1.4 square foot of heating surface for every pound of coal burnt, we have $600 \times 1.4 = 840$ square feet of heating surface. Dividing this heating surface by the grate surface, we have $\frac{840}{20} = 42$ square feet of heating surface to each square foot of grate surface, instead of 32 to 1, as before. The ratio of the cross-sectional area of the tubes, and the ratio of the area above the bridge wall to the grate surface should be about the same as given for natural draft. The foregoing boiler proportions are only suitable for bituminous coal. For anthracite coal we shall need a larger grate, because with natural draft only about 12 pounds of coal per square foot of grate per hour will be burnt. Adopting 12 pounds of coal per square foot of grate as a fair average, we can find the grate surface in a manner precisely similar to that adopted for finding the grate surface for bituminous coal. The proportions of the other parts of the boiler are found by the rules previously given. Sometimes the allotted space for the boilers and the limit of the weight of machinery will not allow us to adhere to the foregoing boiler proportions, and we may be compelled to make the heating surface considerably less than that found by the rules. To find the proportions of the boiler for a 5x5 launch engine, proceed in the same way as given, but allow 8 pounds of coal per I. H. P. per hour instead of 5.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue

Gear wheels and g-cutting. Grant, see adv., p. 16.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N. Y.

20″ Upright Drills. J. E. Snyder, Worcester, Mass.
23″ Upright Drills. J. E. Snyder, Worcester, Mass.
25″ Upright Drills. J. E. Snyder, Worcester, Mass.
28″ Upright Drills. J. E. Snyder, Worcester, Mass.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

S. W. Card & Co., Mansfield, Mass., carry a full line of Stay Bolt and Patch Bolt Taps.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Best silk wiping towels for machinery in the market. S. A. Smith, 23 S. Canal st., Chicago, Ill.

Iron Planers from 16″ to 36″ wide by any length. H. C. Pease & Co., Worcester, Mass.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illustrated. Frasse & Co., 92 Park Row, New York.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

For Portable Key-seating Machines and Stub Ends for small connections, address T. C Dill Machine Co., 726 Girard ave., Philadelphia, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See May 9, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

The best Emery Wheel made is the "Norwich." For particulars send to Montgomery & Co., 105 Fulton st., New York.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing grey iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N.Y.

Steam Boilers: Their management and working on land and sea. By Jas. Peattie. Practical facts from 30 years' experience. 230 pages illustrated. 12mo., cloth, $2.00. Circulars and Catalogue of Books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N.Y.

Patent or shop rights for sale, for perforating iron or steel plates for steam boilers, bridge work, iron or steel ship work, marine boiler heads, equal to drilled work and fifteen times quicker. Samples can be seen and circulars obtained from R. E. Dietz, 60 Laight st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

"Practical Drawing." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including May 23, 1889 issue, 77 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 92 articles have thus far appeared up to and including the May 30, 1889 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES

G. Hallford will build a planing mill at Newton, Ala.

Tim & Co., Troy, N. Y., will build a shirt factory at Cambridge, N. Y.

The Grenada (Miss.) Oil & Compress Co. will add a repair machine shop.

The Anniston (Ala.) Foundry and Machine Works are enlarging their plant.

S. W. Brower will rebuild his saw and planing mill, recently burned at Prospect, Ark.

The Westinghouse Machine Co., Pittsburgh, Pa., are increasing their plant for manufacturing steam engines.

The Richmond & Allegheny Railroad Company expect to have shops at Gladstone, Va., completed by the first of August.

The Akron Hardware Company, Akron, manufacturers of hardware specialties, have reorganized, with increased capacity.

A water-works plant at a cost of about $30,000 will be built by S. Walker, of Milledgeville, Ga. It will be built on the gravity system.

It is said that the Illinois Steel Co., of Chicago, contemplates building works at Milwaukee, Wis., for the manufacture of steel cars.

Wells Brothers & Co., Greenfield, Mass., are exclusive agents for the Stratton spirit level, and they issue a circular setting forth its merits.

The Paris Fire-proof Plaster Cloth Company, of St. Louis, Mo., recently incorporated, with $25,000 capital stock, has broken ground for a factory.

The stockholders of the Fall River Iron Works Co. have voted to increase the capital stock $100,000. This brings the entire capital of the corporation up to $500,000.

The National Switch & Signal Company, recently incorporated, has leased buildings at South Easton, Pa., and will shortly begin the manufacture of its patent switch system.

Within a year, Ypsilanti, Mich., expects to have water-works. The expectation is to get water from an artesian well, and to pay for the work with 30-year 4 per cent. bonds.

A recent election at Georgetown, Ky., nearly unanimously endorsed the water-works proposition submitted to them for their endorsement. Work will be commenced at once.

The Sampson Steel Forge Company, with a capital of $100,000 has been incorporated at Chicago, Ill. The company will manufacture locomotive frames and do general forgings.

The Stover Manufacturing Company, Freeport, Ill., is putting up a building to be leased to the Arcade Manufacturing Company, and to be used for the purpose of making coffee-mills.

English capitalists and Northern iron men have formed a company with a capital stock of $3,000,000, to build four steel mills and blast furnaces at Cumberland Gap, Tenn., near the Virginia line.

H. J. Barron & Co., 76 Cortlandt street, New York, have issued a catalogue, descriptive of their steam heating apparatus for apartment houses. Boilers and radiators are illustrated and described.

Three large saw mills are to be built within six months on Bellingham Bay, W. T; one at Fairhaven, another at Sehome, by the Cornwall Company, and a third near Whatcom, by British capitalists.

A rolling mill, to cost $100,000, and to have a capacity of 50 to 75 tons of bar iron per day, is to be established at Iron Gate. It is expected that this will be followed by a nail factory and other enterprises.

Lewis Johnson, Henry D. Stearns, G. W. Koffskey and W. H. Johnson have incorporated the Johnson Iron Works, to operate a foundry and machine shop at New Orleans, La. Have works in operation.

The Laidlaw & Dunn Co., Cincinnati, Ohio, have received the contract for the pumping outfit for the United States barracks at Newport, Ky. The pumps are to be located at the new reservoirs of the Covington water-works.

The Energy Manufacturing Company, Philadelphia, Pa., report business very good for the past three months. They have received very satisfactory orders for rope hoisting machines and center girders from all parts of the country.

The Board of Public Works and Affairs of Nashville, Tenn., will purchase a new pumping engine for the water-works. The capacity is to be not less than 10,000,000 gallons daily. The board will also durchase a considerable quantity of 36-inch pipe.

The Pittsburgh Reduction Company is a new corporation. The company was formed for the purpose of reducing refractory ores, and producing bronze and commercial alloys. The capital stock is $20,000, divided into 200 shares of $100 each.

The Bates Steel Company, of Philadelphia, Pa., has been chartered, with a capital of $100,000. The incorporators are John F. Bickle, Morton, Pa.; Lewis Wiener, Augustus Hunt, Edward P. Kershow, F. G. Bates, Philadelphia; Isaac L. Miller, William H. Miller, Media; Barton Pardee, Lock Haven.

A little over a year ago the Reliance Gauge Company, of Cleveland, O., leased a three-story block, in which to manufacture their Reliance safety water columns. This was expected, when leased, to be ample for the business for at least five years. Some idea of the way it is growing may be had from the fact that they are already putting up an addition to the block.

Nicola Tesla, an expert electrician, and superintendent of motive power in the Westinghouse shops, Pittsburgh, Pa., has invented a new electric fan motor. The difference between the new and the old machine lies in the point that an alternating current without brushes is used, the current being charged directly into the fields of the magnets, whence the motion is then incited.

W. P. Norton, recently with the Hendey Machine Company, has leased and fitted up a shop at Bristol, Conn., and will manufacture a line of machine tools. For the present he is making a specialty of drills for light, sensitive drilling, and will manufacture the Norton semi-automatic lathe. Mr. Norton starts under very favorable conditions, having a fair number of orders ahead.

The Keystone Rolling Mill, Reading, Pa., which employed over 250 men before the Reading Iron Works failure, since which time it has been idle, resumed operations recently, and will run independent hereafter of the Reading Iron Works, finding a market for its product around Pittsburgh. Seifert's rolling mill, which has been closed since the iron works' failure, has also resumed with 250 men.

The Bonton Foundry Co., of this city [Chicago, Ill.], have for some time been removing their buildings from the old site on Archer avenue, to a tract of land at Thirty-ninth and Winter streets. In the newly constructed plant the latest improved machinery will be introduced, making, as they claim, one of the most perfect foundries in the West. The machine shop has begun operations, and the foundry is ready for melting iron.—*Industrial World.*

Hubbard & Co., axe and shovel manufacturers, of Pittsburgh, whose works in that city were destroyed by fire some weeks ago, have decided not to rebuild in that city, but will build new works at Beaver Falls, Pa. They already have a plant there, and will simply extend it. The firm have recently been reorganized, David M. Long, W. N. Frew and Martha E. Frew having sold their interests to the remaining partners. The firm will continue to be known as Hubbard & Co.

A press dispatch from Green Brier, W. Va., says: The Glenmore Iron Co., organized with Gen. J. R. Anderson, of the Tredegar Iron Works, Richmond, as president, will erect a great plant on the Glenmore estate, three miles from this place. They have acquired 3,000 acres of land, upon which there is a vein of iron ore 40 to 60 feet thick, and six miles long, which can be mined by open cutting. Chesapeake & Ohio Railroad will run a branch line to the mines and works.

The Knowles Loom Co., Worcester, Mass., have begun the erection of extensive new buildings. The main building will be in the form of a hollow square, which on the four sides will be nearly 700 feet long. It will be four stories high, with a tower extending 50 feet above the main building. The total floor space will be 144,000 feet. Besides this, there will be a foundry one story high, with a monitor roof, which will be 480 feet long, and a storehouse 35x104 feet.

The Bates Machine Company, of Joliet, Ill., manufacturing machinists and iron founders, being constrained to increase their facilities in order to keep pace with their trade, are erecting a machine shop in the northeastern portion of the city. Its dimensions are 108 feet wide by 200 feet in length, and it adjoins their foundry, which is 60 feet by 150 feet in length. They are running their works day and night, with a full complement of operatives, and are still behind their orders.

The Eclipse Wind Engine Co., of Beloit, Wis., make a favorable report as to the condition of their business in the line of friction and cut-off couplings and pulleys, many of them going into new establishments. The friction pulleys and clutches used at the Western Electric Co.'s building, the power plant of which we recently illustrated, were furnished by this concern. They have recently shipped several car loads of clutches, pulleys, shafting, etc., to the Minnesota Car Works at Duluth.

The Brown & Sharpe Mfg. Co. have issued an illustrated pamphlet of 34 pages on the *Construction and Use of the Universal Hand Lathe.* The illustrations of parts of the lathe and of special fixtures which they have found of value for use in connection with it at their factory are mostly reproductions of working drawings, and are first-class. The book will be found useful to those interested in manufacturing operations, whether they make use of the particular hand lathe illustrated or not.

The Henderson Steel and Manufacturing Company, of Birmingham, has increased its capital stock by $60,000. It will at once build an open-hearth furnace of 50 tons capacity per day, for which drawings and estimates are now being prepared. A committee has been appointed to receive propositions from land companies or others having manufacturing sites, for location of the plant. The company's office is at Room 3, Wilson House, Birmingham. It expects to have contracts for construction of plant awarded by the 27th inst.

Machinists' Supplies and Iron.

NEW YORK, June 8, 1889.

Iron—American Pig.—The general tone of the market is somewhat firmer, though prices are not quoted higher. The demand for finished iron has somewhat improved. We quote standard Northern brands, No. 1 Foundry, $16.50 to $17; No. 2, $15.50 to $16. Southern brands rule about 50c. per ton lower for corresponding grades. Grey forge, $14.50 to $15.25.

Scotch Pig.—We quote Coltness, $21 50 to $21.75; Gartsherrie, $20; Summerlee, $21 to $21.50; Eglinton, $19 to $19.25; Dalmellington, $19.75 to $20; Clyde, $20.50, and Langloan, $20.50.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—Position by practical mach. and draftsman as supt. or asst. Tubular. AM. MACHINIST.

Wanted—First-class pattern maker; steady work and good pay to the right man. Address Box 104, AMERICAN MACHINIST.

Wanted - By practical, experienced, pushing iron foundry foreman, a position as such on any class of work. Pusher, AMERICAN MACHINIST.

Wanted—Position as foreman by first-class machinist; at present holding same position; heavy work preferred. Address Reliable, AM. MACHINIST.

Wanted—Position as foreman boiler maker, by a practical mechanic who has been foreman a number of years. Address J. W. T., AM. MACHINIST.

A roll turner wants situation; six years' experience in rolling mills in Sweden; have the whole scale for different kinds of rail rolling. Address H. H., AMERICAN MACHINIST.

Tool maker wanted; one accustomed to designing and making tools for turret machines preferred; shop about 100 miles from New York; to a satisfactory man steady work promised. Address, stating wages, experience, etc., P. G., AMERICAN MACHINIST.

Wanted—Foreman boiler maker; must be a man of experience in locomotive boiler work, competent to handle a shop working 300 men. A good position for the right man. Address, stating experience and reference, Foreman B. M., care of AM. MACHINIST.

Wanted—A thoroughly competent and energetic man to take charge of about 100 men in the machine shop department of an agricultural implement factory in Western Canada; none but an expd. man need apply. Agricultural, AMERICAN MACHINIST.

A young man, graduated at a Swedish technical college, and with some years' practical experience both in this country and in Sweden, wants situation as mechanical draftsman; is willing to start at low wages. Answer Ed. Gordon, 20 Warren street, Bridgeport, Conn.

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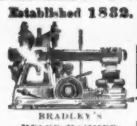

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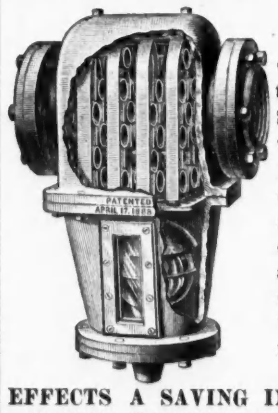

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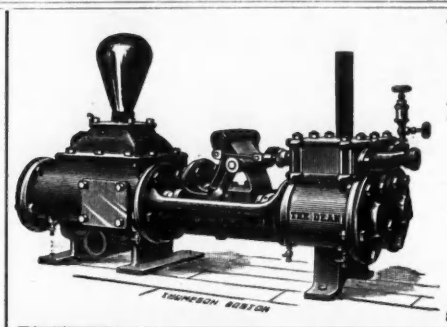

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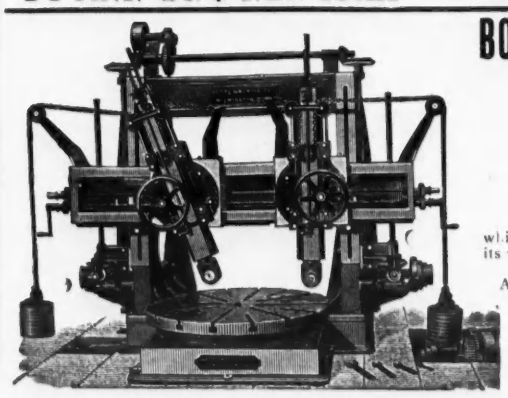

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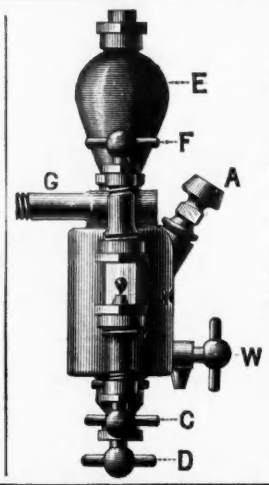

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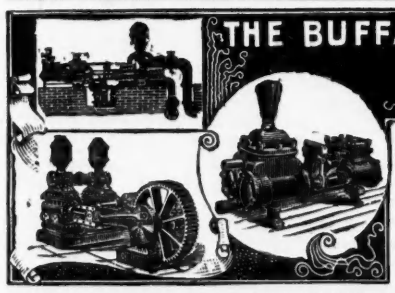

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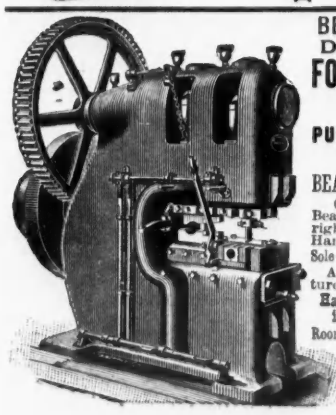

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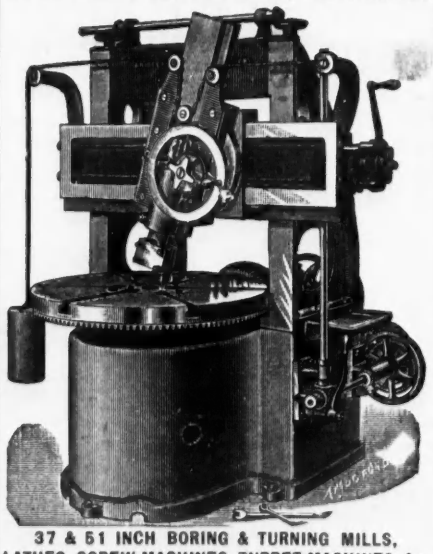

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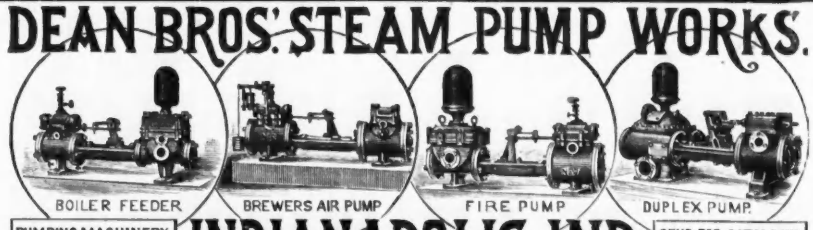

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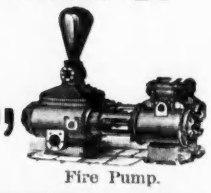

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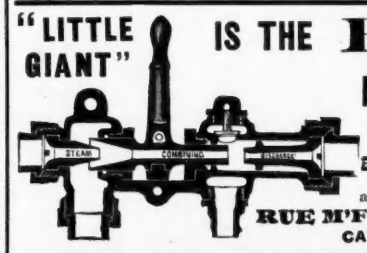

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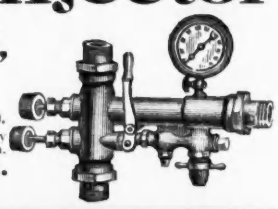

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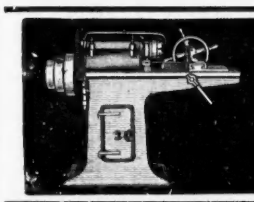

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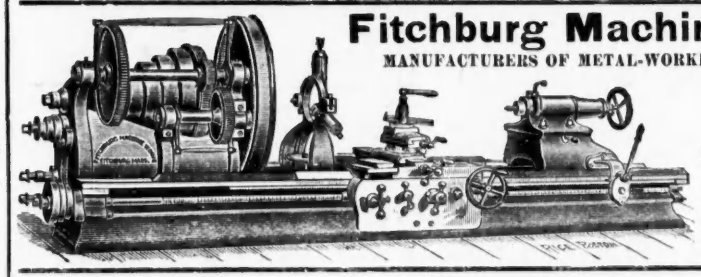

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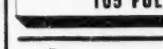

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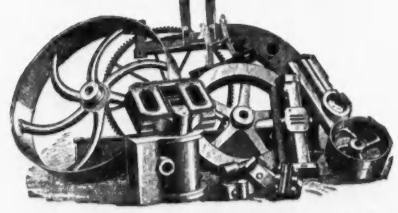

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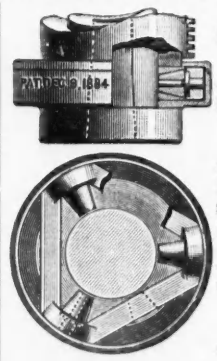

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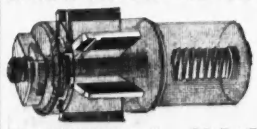

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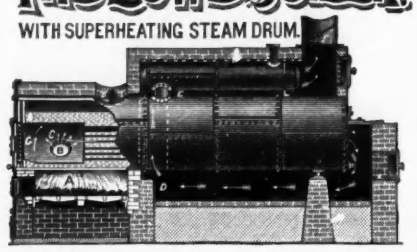

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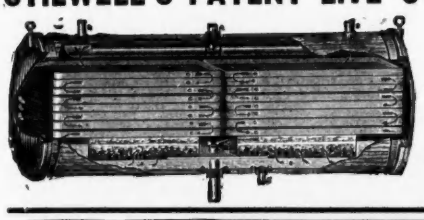

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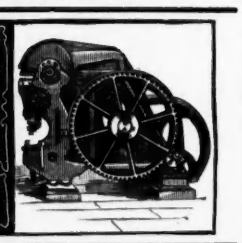

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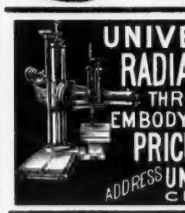

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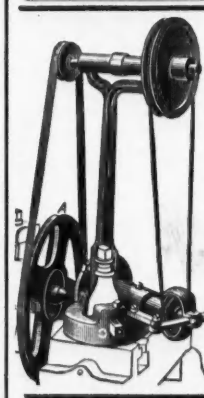

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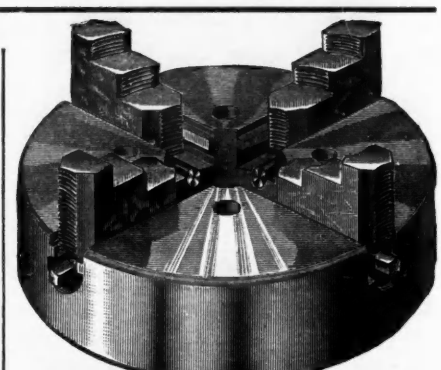

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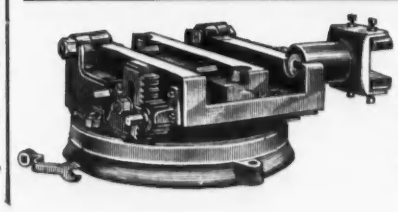

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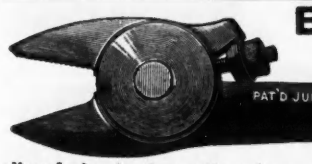

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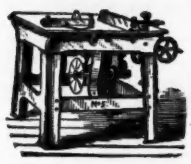

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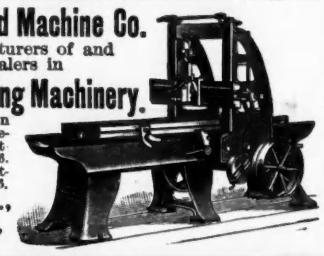

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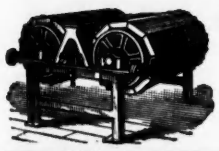

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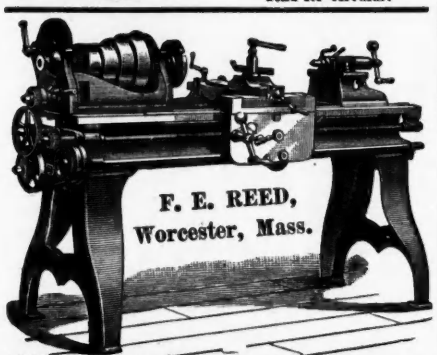

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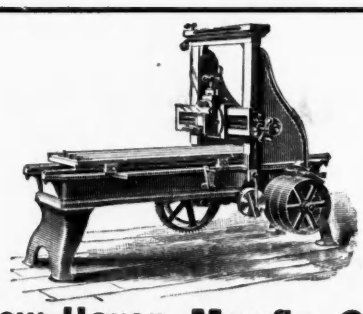

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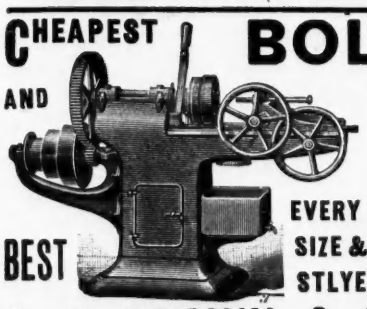

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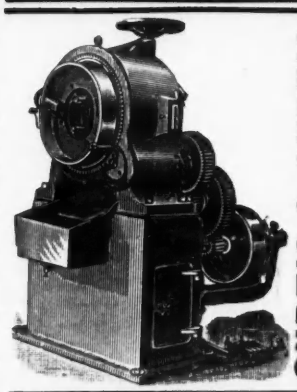

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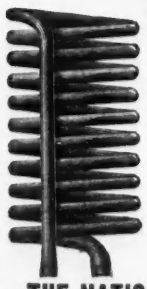

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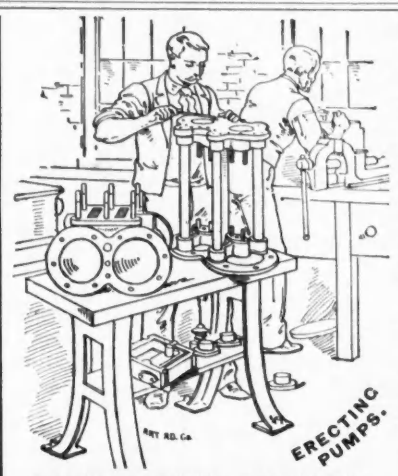

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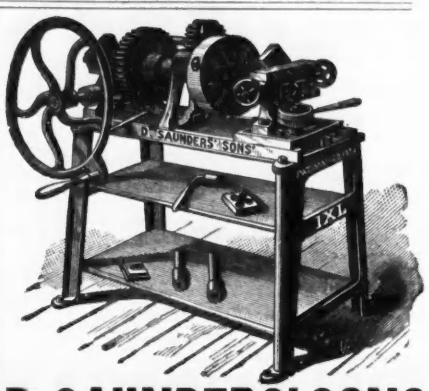

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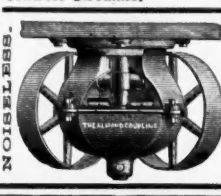

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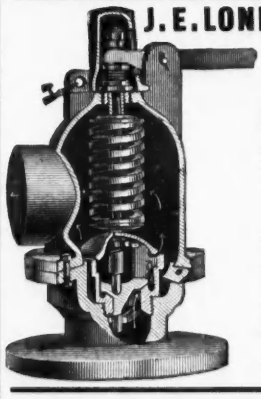

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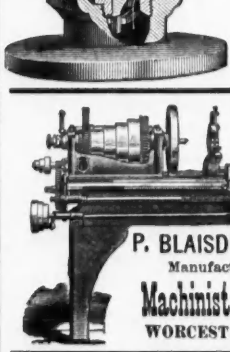

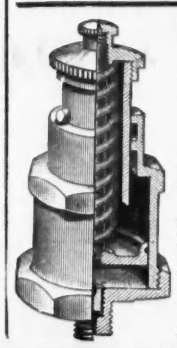

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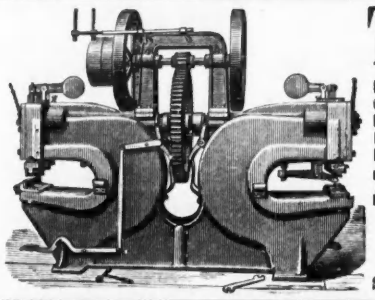

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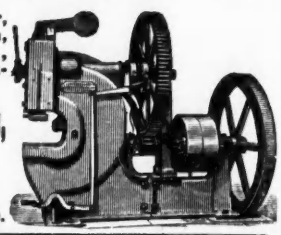

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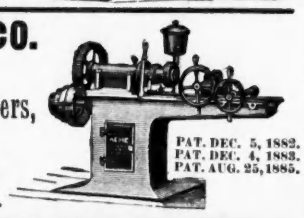

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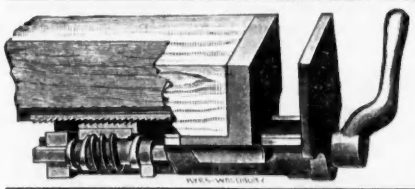

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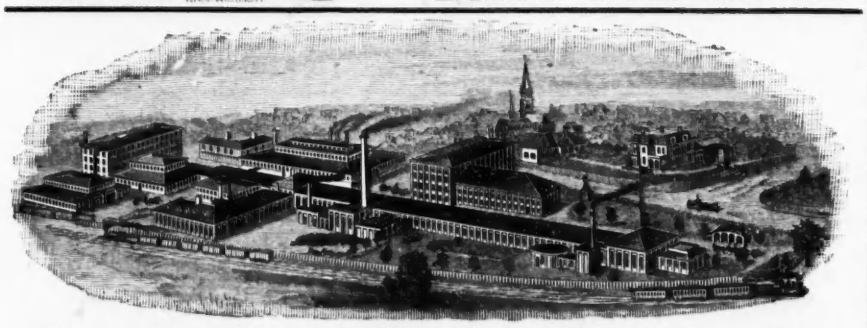

The Corliss Steam Engine Co.
PROVIDENCE, R.I.
Incorporated June, 1856; Established by
GEORGE H. CORLISS,
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"CORLISS ENGINE."
DESIGNER & BUILDER OF THE FAMOUS
"CENTENNIAL ENGINE,"
Exhibited at the Philadelphia Exposition, 1876.

These works have been fully equipped, at great cost, with heavy special tools, of his invention, for the manufacture of this perfected engine, which is a guarantee of superiority in workmanship, and interchangeability of parts, never before attempted in the line of steam machinery.

The public will understand that we have no relations with American or European builders of so-called "Improved Corliss Engines," and that the final and perfected Engine of Mr. George H. Corliss, embodying his latest ideas, is to be obtained exclusively at our works.

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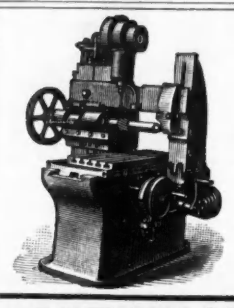

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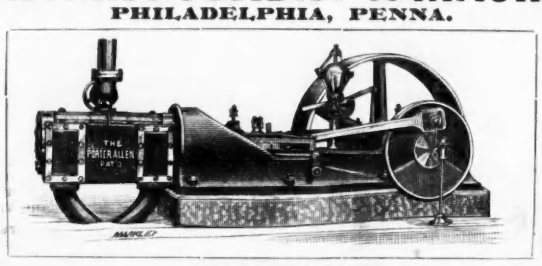

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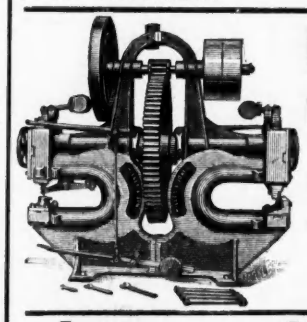

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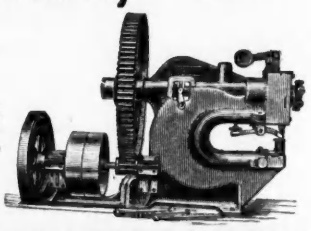

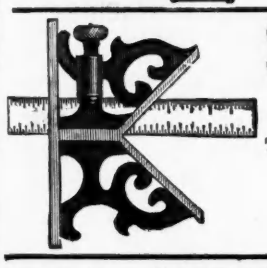

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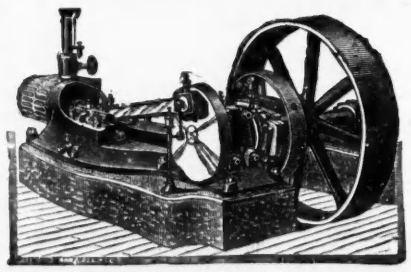

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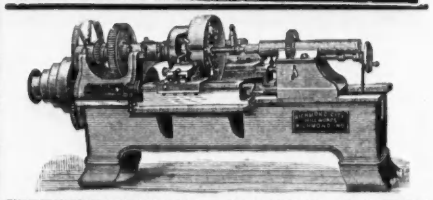

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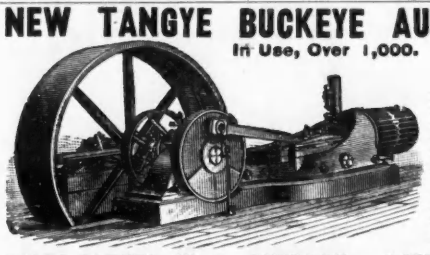
In Use, Over 1,000.

25 to 1,000 H. P.



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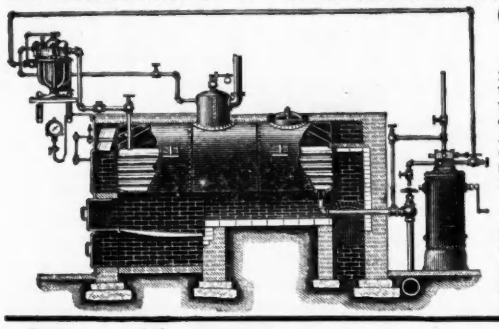

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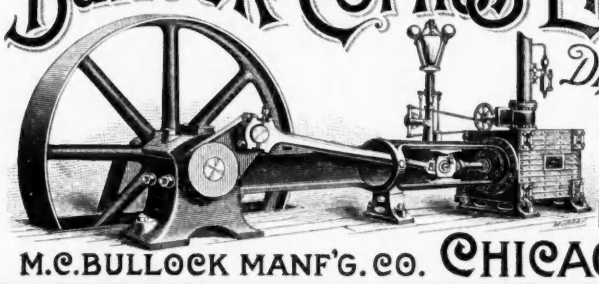

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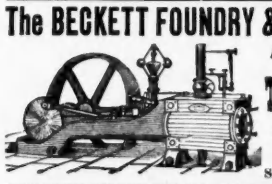

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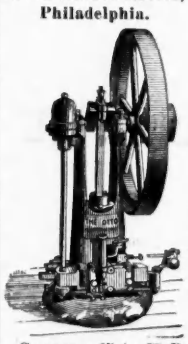

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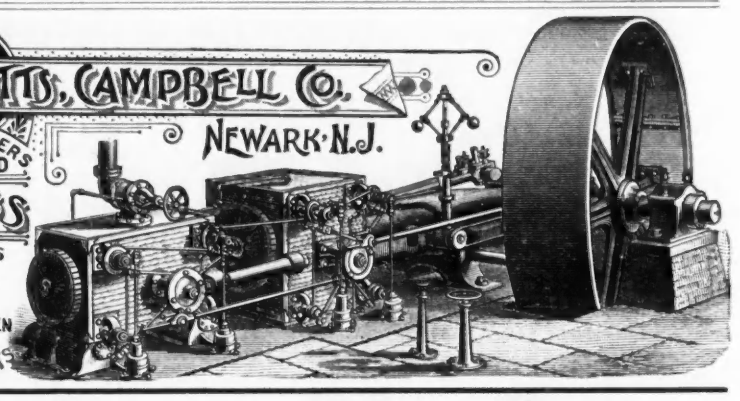

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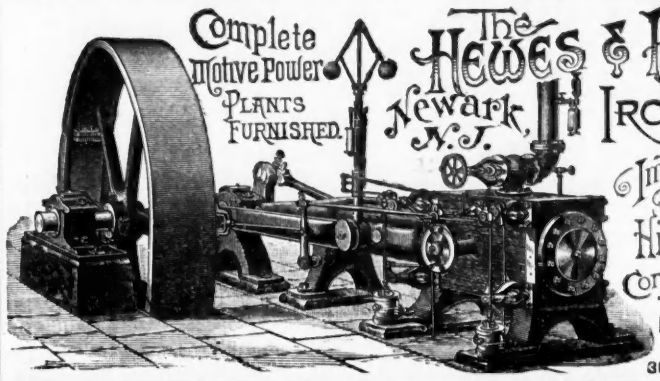

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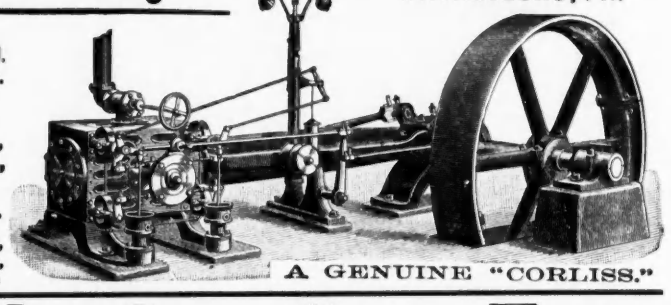

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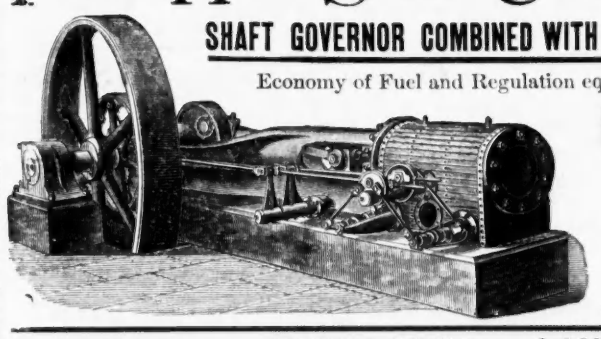

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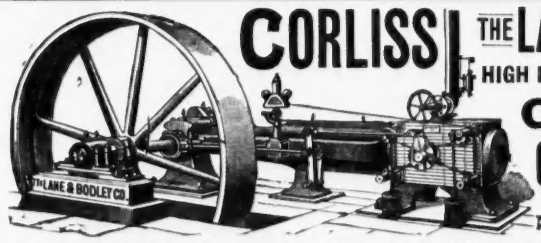

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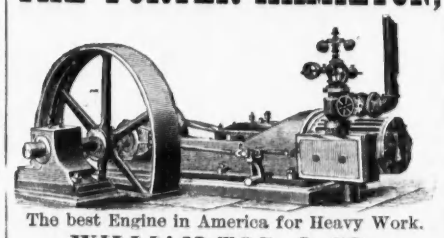

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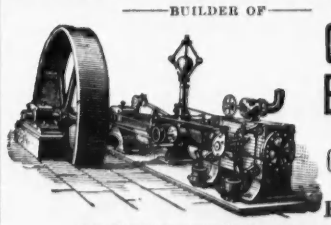

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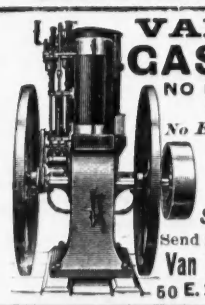

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Send for description and prices.

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Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

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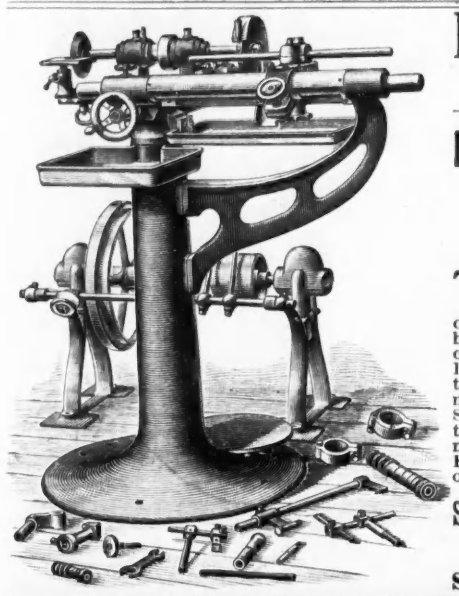

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THIS machine is extensively used for sharpening straight or taper, shell or shank reamers, and for grinding edge and bevel cutters of any angle, straddle and face mills, cotter and hollow mills, and straight or taper milling cutters, cut either straight or spiral, with holes or shanks. It can also be used for sharpening worm or thread tools. All moving parts are adjustable. Movements quick and accurate, simple and mechanical. Spindle has two speeds. Distance between centers, 12". Mills or shell reamers 6" diameter and not over 6" long can be satisfactorily ground. Emery wheels used up to 7" diameter, either with or without water.

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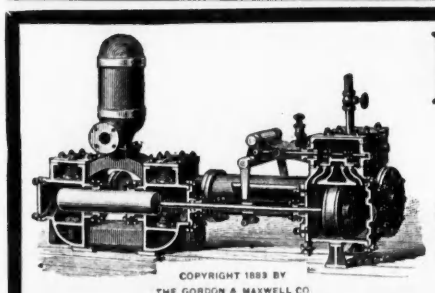

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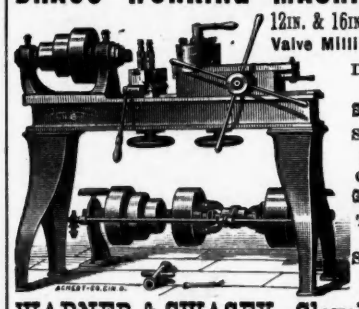

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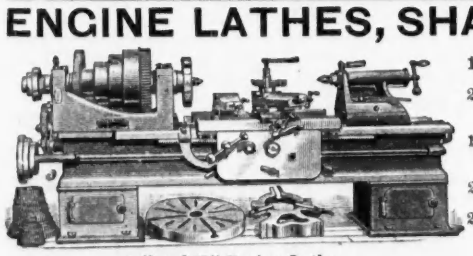

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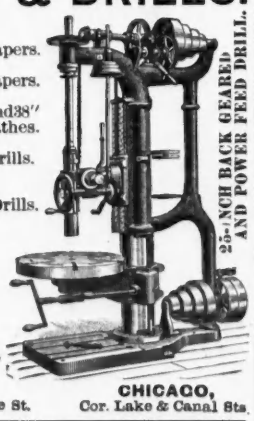

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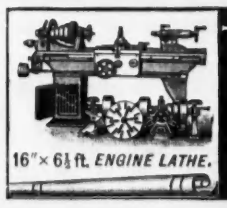

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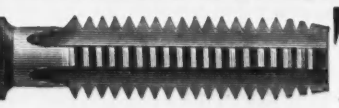

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